MACHINE DESIGN

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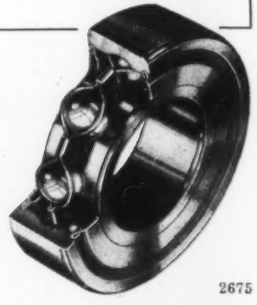

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Materials MAKE the Machine!

Photo courtesy Joseph T. Ryerson & Son Inc.

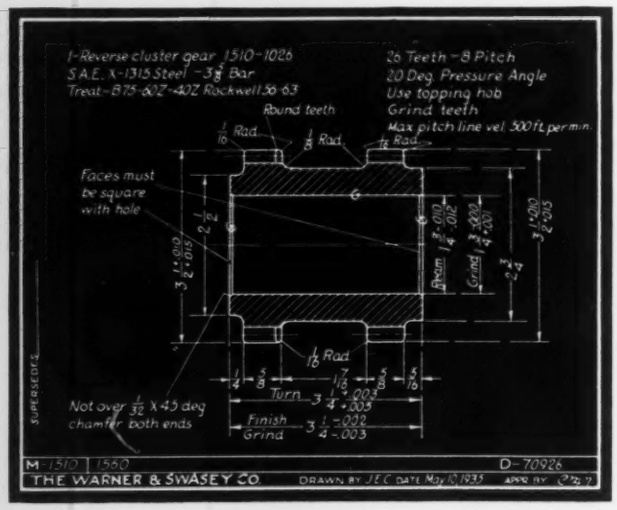
MACHINE DESIGN

October 1938

WORKING with a very limited number of materials of uncertain quality, engineers and designers of days gone by somehow succeeded in creating machines that worked. As a matter of fact, what those men did with the limited experience and limited materials available to them was remarkable, even though their creations may seem rudimentary from a scientific point of view, slow in action and clumsy in appearance. But before we smile too knowingly at the contrast—let us say—between a locomotive of 1838 and a transport plane of 1938, we should remember that the mechanical engineering mate-

rials available to the designer of 1838 could be counted on his fingers, whereas the engineer of today has at his disposal hundreds of alloys and plastics and exact knowledge concerning them. All this is well exemplified by the directory of materials included as a supplement to this issue of MACHINE DESIGN.

Today, as never before, "Materials *make* the machine!" Where deadweight must be eliminated—as in aircraft and in high speed mechanisms—it is of vital importance that materials be chosen to give high factor of safety with low weight. In mechanisms manufactured in quantities for sale in competitive markets, materials must be selected which will give satisfactory service but which shall be low in cost. In power machinery, materials must be specified which will stand up and resist "creep" under the influence of steam,



Example of definite specification not only of material but also of heat treatment—latter denoted by symbols

gases and high heat. In food and chemical machinery, corrosion-resisting materials must be used. In motor vehicle design, the triple requirements of safety, economy and appearance must be provided for in the selection of materials.

Such requirements must be covered by the specification of materials on the drawings, which puts the responsibility squarely on the shoulders of the engineering department. That does not mean, however, that engineers and designers in general consider themselves capable of the unaided selection of vital materials in important mechanisms. They recognize it as a job worthy of a consultation with specialists, and in progressive plants it is being handled in that manner.

A typical "meeting of minds" in the selection of material for an important design detail involves the chief engineer, a detail designer, the metallurgist or chemist, a production engineer, possibly a field engineer, and last but by no means least one or more suppliers of the material or materials under consideration. Then too, if appearance is of importance, an industrial stylist may be included as one of this group of experts.

In all probability the chief engineer and his designer will have the general size, shape and required strength of the part figured out, and will have figures on how many will be required, what the important characteristics must be and what its maximum cost shall be. Weighing all these requirements in his mind, the metallurgist makes tentative suggestions as to the material and its heat treatment, while the production engineer gives thought to how it will be formed and machined. This combined thinking may result in modifications to the design which will cut down on the amount of material needed, improve its heat treating characteristics and reduce the machining cost.

In cooperation with suppliers of material, recommendations are then made of commercial grades which should fulfill the requirements. Samples are submitted, sample parts made up, and these are subjected to careful and complete laboratory and practical tests. When the final selection is made on the basis of these tests and all the other considerations, the complete specifications are drawn up and such as are necessary will finally be transferred to the working drawing, as in the case of the part shown herewith.

Specifications Cover Every Detail

In many cases the specifications will cover not only a definite tradename or SAE number, but also an exact analysis, a high cleanliness range and an exact grain size, to insure that the alloy will respond favorably in every instance to the carefully detailed heat treatment. It is now possible to obtain from stock, material certified to be within such exacting limits.

If the part is to be a drop or pressure forging, a stamping, a die casting, or a molded plastic, the chances are that it will be produced in a custom forging, stamping, die casting or plastic molding plant. In such event there invariably is consultation on the part of the company engineers and designers with the custom producers of these parts before final specifications are drawn up. The many and intricate problems of forging, stamping, casting and molding dies, which are rather out of the realm of the average designer, do have a very definite bearing on the problems of specification. The same is true of the metallurgy of die castings and the chemistry of plastics. Consultation with specialists is the recognized procedure.

While the engineer of 1938 cannot hope actually to carry in his mind the existing manifold materials, it behooves him to keep up with the march of progress in materials by keeping an eye on new developments in materials. Just because a specification is written into a design and on the drawings is no assurance that it will continue to be for any length of time "the one best material." Alert designers will raise a question the minute they hear of a new development in materials which seems to affect the design, and will promptly get together with the other specialists to review the case and to bring the specification up to date.

Scanning THE FIELD FOR Ideas

BECAUSE of the tremendous cutting power of what commonly is called a "sand blast", much difficulty has been experienced in making a blast nozzle which will stand up for any length of time under the concentrated flow of the air-driven sand,

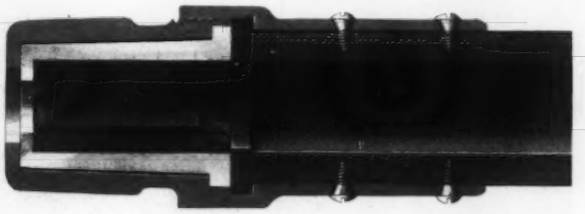


Fig. 1—Abrasion-resisting material as liner for blast nozzle withstands action of sand, grit and steel shot

steel shot or other abrasive grit. The Pangborn Corp. has met this situation by means of an abrasion-resisting nozzle liner, the design and application of which is shown in *Fig.* 1.

The material selected for this unusual service is Norbide, which is boron carbide produced by the Norton Co. Liners of this type will stand up for at least 750 hours service with sand and for at least 1500 hours with steel abrasive. Design is such that hose connection and nozzle cover are fully protected from rebounding abrasive grains, while stream contour and velocity have been improved.

"Time Capsule" Is Cupaloy

MATERIALS play a very important part in the make-up of the much talked-of "Time Capsule" designed by engineers of the Westinghouse Electric & Mfg. Co. for preservation of objects and records of our civilization for the benefit of mankind 5000 years hence. This unusual creation, which is shown diagrammatically and in finished form in *Fig.* 2, was lowered into a 50-foot well on the site of the company's exhibit at the New York World's Fair, on September 23. Copies of a time-resisting book of record, giving precise location of the capsule and directions for its recovery, are being placed in libraries, museums and other repositories throughout the world, in the hope that some may survive to guide archaeologists of the year 6939 A. D.

The capsule, which—as the illustrations show—resembles a slender torpedo, was machined in seven sections of cast cupaloy, a heat treatable alloy of copper, chromium and silver. This alloy is strong, hard and has a high degree of corrosion-resistance. In making this alloy, copper is melted and then deoxidized with boron. Next copper-chromium hardening briquettes are added, followed by a small amount of silver. After thorough stirring in a crucible furnace at 2500 degrees Fahr., the alloy is cast into molds in shape for machining. The capsule was turned, bored and polished.

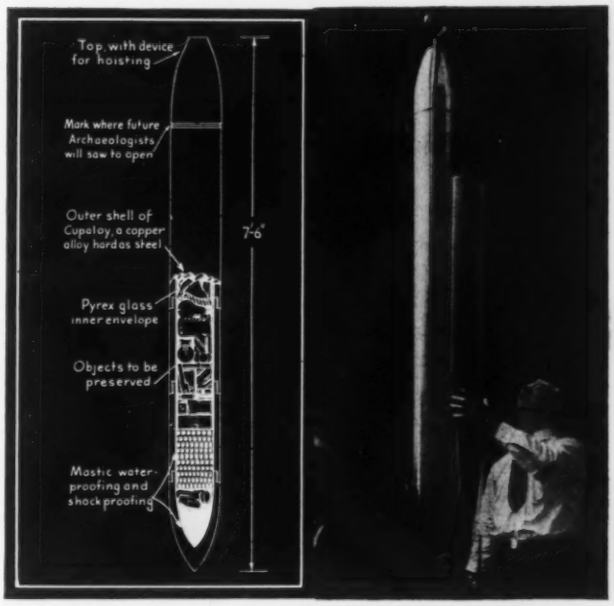
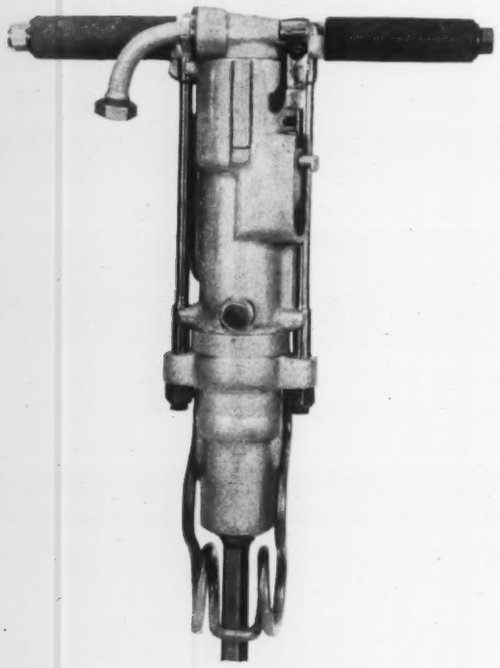

Top with device for hoisting
Mark where future Archaeologists will saw to open
Outer shell of Cupaloy, a copper alloy hard as steel
7'-6"
Pyrex glass inner envelope
Objects to be preserved
Mastic water-proofing and shock proofing

Fig. 2—Designed to preserve contents for 5000 years, this capsule contains records for future archaeologists

Objects to be preserved, including moving picture films and micro-filmed books and records, are in a 6-foot inner pyrex glass crypt which was sealed, evacuated and then filled with an inert gas which will act

(*Continued on Page* 42)

Fig. 1—Many drop forgings are used in this hard rock drilling machine



Selecting Forgings

By George Z. Griswold

BESIDES various special conditions which may bear on the subject, three factors are always taken into account by a designer when he considers specifications for parts in a machine: Proposed function of the parts, feasibility of making them by different methods, cost. In many cases, any one of several methods of producing parts may be used, the following article dealing with the production and application of forgings.

Forgings have certain principal advantages, prime one being the fact they combine great strength with minimum cross-sectional area. Moreover, they reduce machining time and costs because less material is left to be machined or ground, and because the homogeneous structure permits ease of machining. In the case of drop forging and coining, limits may be considerably less than plus or minus .005-inch—sometimes actually .001-inch—and plus or minus ¼-ounce in weight.

Forgings are integral units which are resistant to operating stresses because of their fiber flow and grain structure which are produced in the process of kneading. And forgings after heat treatment have uniformity of physical properties among the various units in a quantity being processed.

Four fundamentals, laid down by forgings engineers, prohibit the indiscriminate use of forgings. These fundamentals are not final or decisive. They are often circumvented, but they serve as a helpful starting point.

They may be enumerated as follows:

1. Because a forging requires a die, draft is required in those sections which form protrusions or depressions in the forging.
2. There should be good fillets.
3. Deep recesses should be avoided.
4. Thin sections, ribs, or webs should be no less than 3/32 to ⅛-inch thick.

As previously implied, these "rules" are often disregarded. Forgings are being made without draft angles and with thin sections, depending in part on the forging technique and on the metal used.

Where the question of using forgings revolves about the matter of cost, the cooperation of a metallurgist, forgings engineer, production man, and designer is usually needed to determine if it will be cheaper, considering all angles, to have parts forged or to have them made by another method.

The cost element has several aspects. Immediate first costs of making forgings occasionally conceal long-range considerations. One machine manufacturer, for instance, when designing a new machine, deliberated and then determined against the use of forgings for certain parts. The machine at first was made only in small lots, and it was felt that the cost of making fairly complicated dies would run up the expense. Accordingly, another method of fabrication was used.

The machine subsequently found a ready market and soon it was being made in increasingly greater

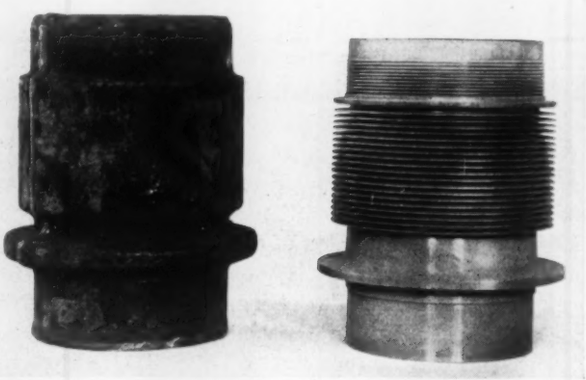


Fig. 2—A bar of steel was forged and pierced on an upsetter to make this cylinder barrel

ngs Machine Parts

quantities. Use of forgings, having been once discarded, was forgotten, despite the fact it was later proved that such a volume of production would have fully justified specification of forgings, and that the machine would have been even more successful had they been employed from the beginning.

Elimination of much machining work — often as much as 25 to 60 per cent when the forging machine or upsetter is used—patently will affect costs. Uniformity of physical properties in interchangeable parts is another point to be considered.

The ingenuity and skill of the forgings engineer are constantly increasing. Parts which formerly were thought impossible to be forged are being made daily in this manner. The forging press has proved itself more than an auxiliary of other types of forging equipment. Its possibilities have only been tapped. But at present it is limited in general to designs which are smooth, uniform in section and symmetrical in shape. Usually equipped with mechanical ejectors which raise the forging from the die on the back stroke of the ram, forging presses have made possible the elimination of customary draft angles in design.

A trend has appeared toward use of higher carbon steels for forgings, such as S.A.E. 1030, 1035, 1040. Perhaps the principal reason for this development has been the desire to avoid the use of steel with relatively stringy fibers—S.A.E. 1020, for instance. Higher alloy steels, especially those containing molybdenum, also are coming into greater use for forgings. Molybdenum alloys are distinguished from others in that they can be machined readily at high hardness after heat treatment.

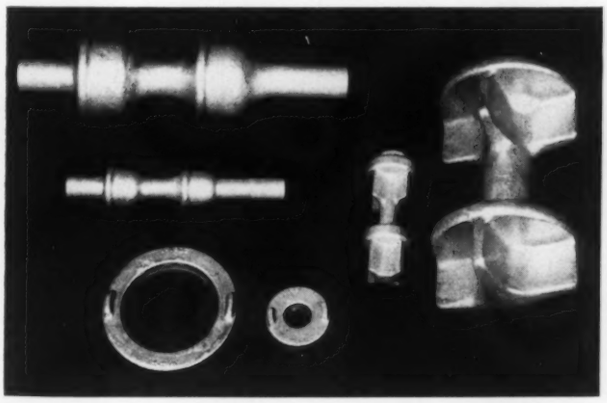


Fig. 3—These forgings are made of high nickel-chromium analysis, for use as valve parts

Fig. 4—Load binder, left, has eleven forgings. Other examples of drop forged parts are shown at right

When resistance to various types of corrosion—by commercial chemicals, crude oil, sewage sludge, acid solutions, sea water— is desired, nonferrous forgings have many advantages. Copper, brass and other copper alloys, such as high strength bronzes, are finding increasing favor. The fine, compact grain structure and freedom from porosity make brass forgings easily machined. Silicon bronze and other copper-tin alloys, such as manganese bronze, lend themselves readily to forging.

Illustrations in this article show specific examples of the use of forgings to attain various characteristics demanded by the equipment. They suggest a few of the advances in technique which have widened the scope of possibilities for the designer in specifying forgings.

The Sullivan L-12 hard rock drilling machine shown in *Fig.* 1 has drop forgings in these parts: Back head, throttle valve handle, sliding cover for exhaust, cylinder, buffer ring and chuck housing. S.A.E. 4615 alloy steel is used for the back head, exhaust sliding cover, cylinder and chuck housing; S.A.E. 3312 for the buffer ring; S.A.E. 1020 for the throttle valve handle. Careful heat treatment increases the margin of strength and stamina.

A bar of steel is progressively forged and pierced on an upsetting machine to make the Lycoming aviation cylinder barrel in *Fig.* 2. Steel used is S.A.E. 1050.

The three diameters are notable. Another feature is the fact the metal on the inside of the cylinder is more dense than that on the outside, a result made possible by a special process.

A group of forgings employed as valve parts is shown in *Fig.* 3. These drop forgings are made of a high nickel-chromium analysis required for the resistance of exceedingly high temperatures and pressures. Another interesting valve problem involved the need for a hydraulic valve which would resist corrosion in contact with water. Corrosion usually occurs in a valve at the point where the pipe enters the valve. A special bronze forging was used, with the following composition: Copper, 59.50; lead, 0.30; tin, 0.75; balance, zinc.

Eleven forgings went into the load binder in *Fig.* 4. Ingenuity on the part of the forging engineer was required here, and the combined facilities of a forging hammer, upsetter, and press were necessary. Strength was improved by using forgings for the hook jaws of a pipe wrench, also shown in *Fig.* 4. These jaws were drop forged of alloy steel and heat treated to within precise limits.

Fig. 5 shows some of the complex designs required in forgings for aircraft, where ribs as small as 1/16-inch thick on parts two or three feet long are often specified. Fillets are sometimes of such small radii that it is difficult to cause the metal to flow into deep recesses. Steel used is usually chromium-molybdenum alloy. The landing-gear fork, *B,* might be easily forged from carbon steel, but when a chromium-molybdenum alloy is used, metal flows less readily. The I-shaped arms have webs only 5/32-inch thick. Moreover, the thin sections of the arms cool more rapidly than the opposite end of the forging, with its large diameter.

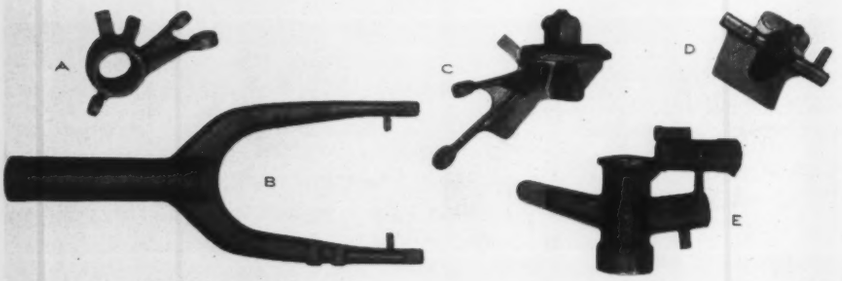
Cold Pressed Machine Parts

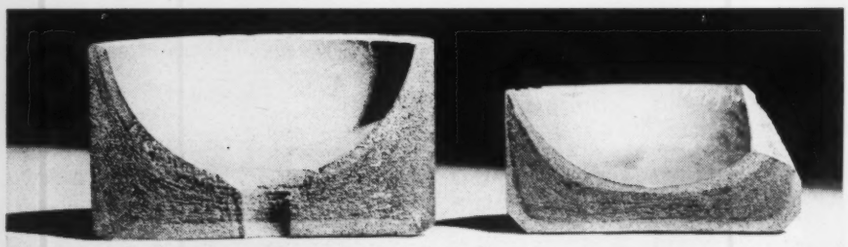
The illustrations described thus far have shown hot forgings. In *Fig.* 6 are some cold forgings produced on coining presses of the knuckle type. These have been especially satisfactory because of the pronounced "dwell" at the bottom of the stroke, which holds the metal long enough for it to take a set after the flowing action has subsided.

The two cut-away pieces at the top of *Fig.* 6 show the grain flow produced in cold pressed work. Integrity of the fibers contributes to strength of the parts. Lower half of the illustration shows steps in producing two machine parts from rough blanks.

In the final analysis, before deciding upon how a part is to be made, a designer will do well to study the cost problem from all angles and then call in a competent forging specialist. A simple change in design often makes it possible to forge a part and still obtain the basic shape and size originally required. Even though the cost should prove to be high, this may well be justified if the part is to be subjected to severe operating conditions.

MACHINE DESIGN wishes to take this opportunity to thank the following organizations for assistance in the preparation of this article and for the illustrations used: Drop Forging association, Cleveland; Revere Copper & Brass Inc., New York; Steel Improvement & Forge Co., Cleveland; Transue & Williams Steel Forging Corp., Alliance, O.; J. H. Williams Co., Buffalo.





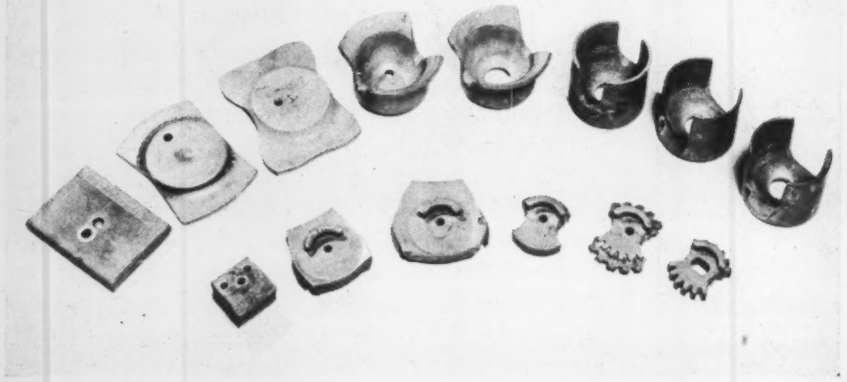


Fig. 5—Top—Examples of some of the complex designs required in forgings for aircraft

Fig. 6—Left—Grain flow produced in cold pressed work is shown in two cut-away pieces. Below are steps in producing two parts

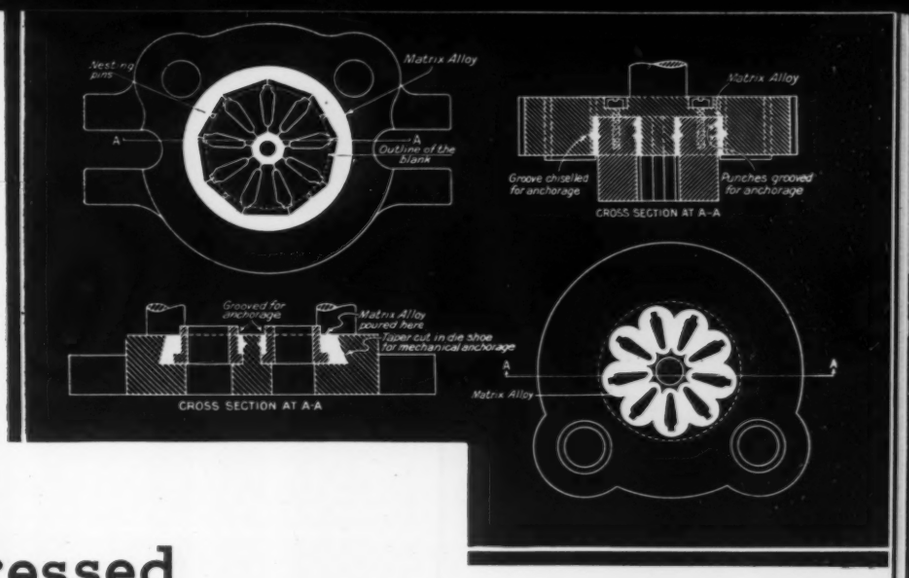


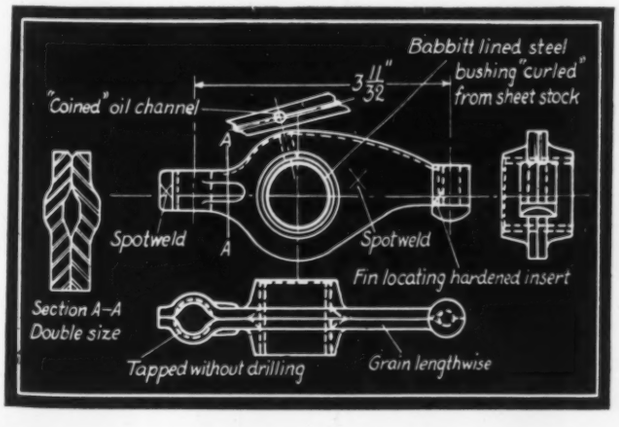
Fig. 1—Die and punch for piercing armature core laminations for sewing machine motor. The nine sections of this die are anchored in place with "expanding metal", without screws or dowel pins. The punches were then located in the die holes and were anchored in the same manner. (Courtesy Cerro de Pasco Copper Corp.)

Stamped and Pressed Metal Parts in Modern Design—Part II

By Guy Hubbard

Fig. 2—Above—Copper hydrogen brazed, pressed steel rocker arm before insertion of sheet metal bushing

Fig. 3—Assembly drawing, below, reveals several of the design features of this Toledo pressed steel rocker arm



ENGINEERS can design more effectively when they have some idea of the ways and means of the manufacturing processes through which the parts they conceive mentally will be brought into being physically. That is what we had in mind in the conclusion of the first article when we said: "We will in the next instalment of this series seek to draw aside the veil of mystery far enough to get some useful impressions of what is doing in the pressed metal industry."

In the preface of his book, *"Plastic Working of Metals and Power-Press Operations"*, Edward V. Crane opens the discussion in this manner: "The power press itself consists essentially of a substantial frame carrying a reciprocating slide; a crankshaft and a connecting link to reciprocate the slide; and a clutch and flywheel to store and deliver energy. Variations upon this simple theme are numerous but the principle remains practically the same.

"The tools are commonly two members, a die attached to the press frame and a punch attached to the reciprocating slide. These tools co-operate to cut, bend, pull or squeeze the metal blank into the desired shape. In every case the metal is stressed beyond—*and usually far beyond*—its elastic limit."

Types of Dies and What They Do

The writer is indebted to The Geometric Stamping Co. for the suggestion that an effective way to give engineers and designers an idea of the wide range of stamped and pressed metal work may be to enumerate the more common types of dies used, discussing each

type briefly. In line with this, the tools can be classified under three main leadings: Cutting, shaping and combination dies. Cutting dies shear or punch, shaping dies change the form or shape of the blank and combination dies combine these functions.

Plain blanking dies (See *Fig.* 4) are of the cutting type. They shear simple, flat, unperforated blanks from the sheet or strip. *Follow dies* (sometimes called progressive, tandem or gang dies) have two cutting members. The first perforates and the second cuts out—two strokes being required to complete the part, a washer for instance. *Gang* or *multiple dies* are blanking dies designed to produce several blanks at each stroke.

Compound Dies Do Work in One Stroke

Compound dies are constructed with a punch and die in both upper and lower faces. They do the same work in one stroke as a follow die does in two—and more accurately. *Perforating dies* (See *Fig.* 1) are gang dies of cutting type, designed to punch a number of holes at each stroke. *Shaving dies,* also of the cutting type, are used to trim raw edges of thick blanks. *Burnishing dies* give extra smooth finish to these edges, following shaving. *Embossing dies* (See upper view in *Fig.* 6) "raise" letters, low ribs, designs, etc. in shallow relief on the surface of work.

Plain drawing dies (See *Figs.* 5 and 6) shape a part from a flat blank by deformation and flow of metal. *Redrawing dies* (See *Fig.* 5, left side) are used to increase depth, it being impractical to draw a shell deeper than its diameter in a single operation. *Forming dies* are used to shape a part from a blank without drawing. *Combination dies* blank out the piece and draw or form it—all in one operation.

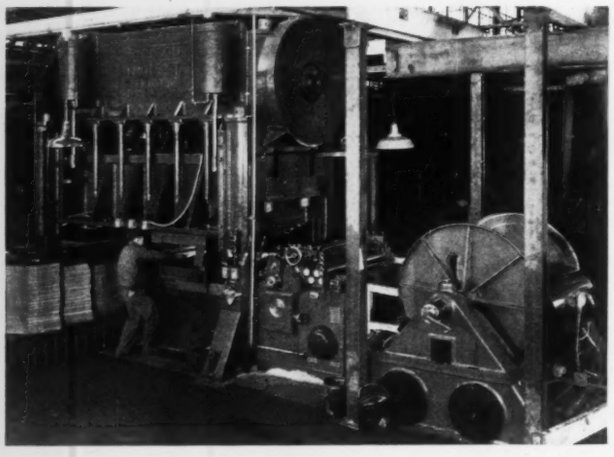


Fig. 4—Roll feed draws wide strip from coil through roller leveler, then feeds it into fender blanking press

Double action dies are combination dies having two slides, while *triple action dies* have three slides and may combine three operations such as blanking, drawing and embossing. *Bending dies* do simple bending operations, and *curling* (or *wiring*) dies form beads at the top of drawn cylinders.

To amplify somewhat on the illustrations referred to very briefly in the foregoing paragraphs, let us first consider *Fig.* 1. This not only is an excellent example of a punch and die set designed for perforating, but it likewise demonstrates how the cost of such a set of press tools can be held to a minimum—in this case through use of bismuth-lead-tin antimony "expanding metal." The diagram indicates clearly just how the nine sections of the die have been anchored in place without need for screws or dowel pins—the alloy having been poured around them. Following this, the punches are located in their respective die openings and are anchored in the same manner. This special alloy, which melts at 248-degrees Fahr., expands about .002-inch per inch when it solidifies—thus locking the sections securely.

Turning next to *Fig.* 4, we see the lengths to which the automobile industry can afford to go to speed up a comparatively simple blanking job. This setup, which is producing front fender blanks from coiled cold rolled strip steel in the Pontiac plant, embodies a roll feed combined with a roll leveler. This straightens the stock and feeds it between the dies after each stroke of the big press.

What might be called a companion setup to the one just mentioned is that depicted by *Fig.* 5. In this instance several dies are being used simultaneously in one large press, in the drawing of front fenders. It should be noted that instead of trying to accomplish the entire draw by means of one large, complicated die—which would be expensive and impractical, if not impossible—the operation is broken down into several stages involving relatively small and simple dies. The operator at the left is redrawing the "hooked-over" nose end.

Alloy Dies Are Cast to Shape

Another example of the important role played by alloys in the field of pressed metal, is furnished by the two sets of drawing dies shown in *Fig.* 6. These dies—instead of having been "sunk" by conventional mechanical cutting methods—have been cast to shape so closely that only a little hand finishing has been required. The metal from which they are made is Strenes C, a chrome-nickel-molybdenum alloy with high steel base. It has a minimum tensile of 50,000 which can be raised by heat treating to 75,000 tensile and 525 to 550 Brinell. The material is close grained, takes a high polish and its graphitic surface lubrication keeps the dies from galling and "picking up." Dies of this kind are good for extremely long runs and their cost and upkeep is low.

The set shown in the upper part of *Fig.* 6 is for drawing and embossing tops for the agricultural machine called a grain drill. One of the parts produced

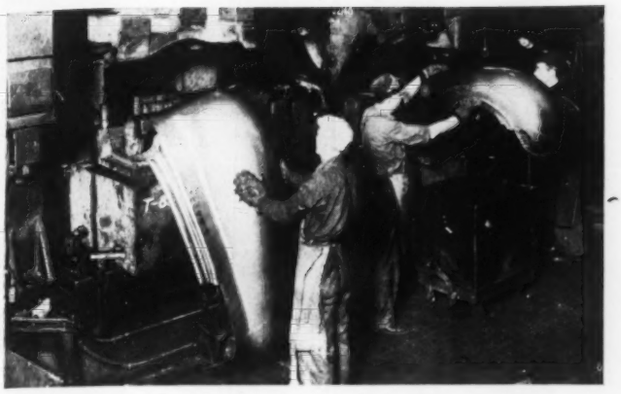
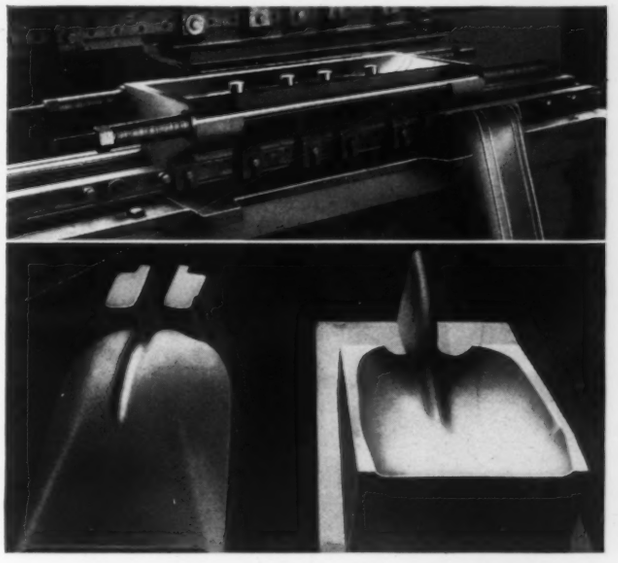


Fig. 5—In press at the left several partial drawing operations on front fenders are being performed simultaneously. Note operator in foreground redrawing nose

Fig. 6—Drawing dies below are of chrome-nickel-molybdenum alloy with high steel base—cast to shape, thereby eliminating machine finishing of working surfaces



by this set of dies is leaning against the side of the press. The lower view is of a pair of these cast dies designed for forming scoop shovels from sheet steel. This set is shown because it gives an unusually clear idea of the relation of a drawing die to the part which is produced therein.

The writer is indebted to the Advance Foundry Co. for the foregoing information on—and for the illustrations of—these cast drawing die sets, both of which were made by that company.

Having outlined this much about punches and dies, it is in order at this point to turn back to more definite consideration of a typical machinery part produced from sheet metal by stamping and forming in dies. Through the courtesy of James M. Leake of the Toledo Stamping & Mfg. Co. we are able to present as our typical example a very interesting new development on which patent is pending. This detail—a light, but strong and neatly shaped rocker arm for the valve mechanism of internal combustion engines—is depicted photographically and diagrammatically by *Figs.* 2 and 3 respectively.

Rocker Arm Is Made in Two Parts

This rocker arm is made up of two sections, a left and a right, which are formed from identical sheet steel blanks—the material in the design shown being 11-gage stock, with grain running lengthwise. The two halves are finished in the dies, ready for assembly. This work includes: Accurate sizing of the hole into which the "curled up" sheet metal bushing is pressed; embossing of the lateral stiffeners at the adjusting screw end; "coining" of the oil channels and forming of the half-rounds at the ends.

Assembly is effected by the process known as copper hydrogen brazing, which sweats the two halves together into what essentially is one solid piece. The two spotwelds indicated in the diagram, *Fig.* 3, are merely to hold the two halves in position while brazing. It will be noted that the coined oil passages become an oil hole (it can be a curved hole if such is desirable) and the central bosses become a double hub for the rocker bearing.

The half-rounds at the ends of the arm become holes into one of which the adjusting screw is threaded and into the other of which the shank of a cold upset contact button is brazed. Note that this shank has a fin on one side which serves to locate the centerline of the curved contact surface of the button exactly parallel to the axis of rotation of the arm.

Mechanical strains set up within the halves during drawing and forming operations are thoroughly relieved by the heat of the brazing process. The curved face of the contact is hardened by application of cyanide.

One of the advantages of the double ply construction is the fact that the hub extends outward from each half, making it unnecessary to draw each hub any more than half the combined length of the hub bearing. Also this method places the supporting web in the proper location to give the greatest strength. The inevitable radius inside the hub where the two halves join forms an ideal reservoir for oil. In some applications this groove is purposely increased to permit the use of a wick for lubrication to the contacting ends of the rocker arm.

This pressed steel rocker arm is representative of an increasing number of machinery parts in the making of which modern methods of assembly—welding in particular—reduce costs by making simpler press operations possible. Other designs of this kind will be dealt with in a forthcoming instalment, which will include discussion of designs—both large and small—which are being successfully stamped and drawn from sheets and strips. Attention will also be given to drafting room problems involved in the designing of such parts.

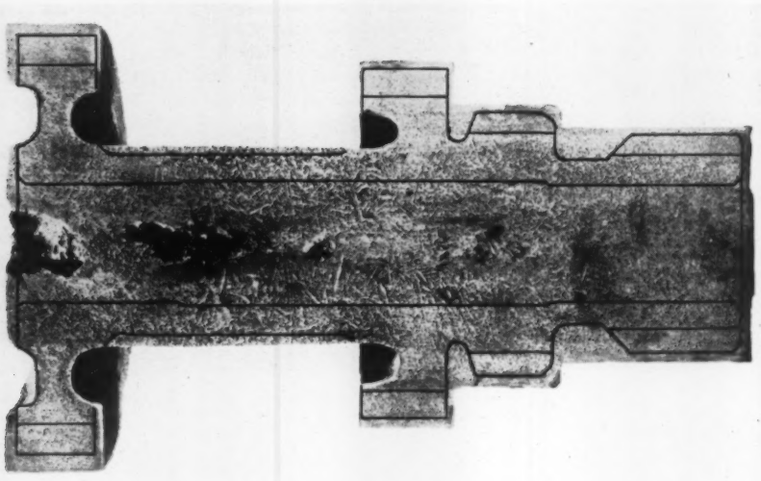


Fig. 1—Photomicrograph of cluster gear shows homogeneity of metal where needed. Center of gear is bored for shaft

Ford Turns to Castings

By
A. H. Allen

COMPETITION between castings, forgings and welded assemblies is an ever-changing race, with constant jockeying back and forth between the leaders. When the favor of a chief engineer or designer turns, for example, toward forgings, the castings producers spur their research brains and technical experts in the direction of perfecting new qualities in their product, new possibilities for its application and new economies in its use. Lately the rapid strides which welding has been making have meant redoubled efforts on the part of foundries and forge shops, evidence of which is readily apparent upon close inspection of the materials directory accompanying this issue of MACHINE DESIGN.

Perhaps in no other industry is this race so keen as in the automotive industry, and perhaps in no other industry have such important advances been made toward new applications of materials, particularly on the part of the Ford Motor Co. Ford operates the largest foundry in the automobile industry, and one of the largest in the world. It is ably managed, and its operators show no reticence in pushing forward into uncharted fields for castings uses and production methods.

For this reason a review of some of the important development work in progress in the Ford foundry is of interest to those concerned with specifying

(*Continued on Page* 46)

TABLE I

Cast Steel Analyses and Heat Treatments

Type	Parts	Carbon	Copper	Silicon	Mang.	Chrom.	Phos.	Sulphur	Heat Treatment and Hardness
No. 1.	Clutch pedals and steer. wheel hub	.15-.35	1.50-2.00	.60-.80	.40-.60	.....	.08 max.	.08 max.	Normalize to brinell hardness of 163-207
No. 2.	Truck ring gears and parts to be carburized	.28-.35	.50-1.50	.40 max.	.30-.45	.90-1.20	.05 max.	.05 max.	Normalize: carburize and direct quench or reheat and oil quench and draw to rockwell "C" 58-62
No. 3.	Centrifugal castings trans. countershaft and differential ring gears	.35-.40	.50-1.50	.40 max.	.65-.80	.90-1.10	.05 max.	.05 max.	Normalize to brinell hardness 170-196. Harden gears as per part prints
No. 4.	Rear axle shaft housing flange truck universal joint housing connecting rods	.35-.45	.50-1.50	.40 max.	.70-.90	.....	.10 max.	.08 max.	Normalize to brinell hardness of 163-207. Univ. joint hous. to remain as normalized. Rear axle shaft hous. flange harden as per part print. Conn. rods oil quenched and drawn to brinell 255-286.

Automobile Industry Points Way Toward Method of Creating Sales

BEFORE many more weeks have passed, the annual display of new cars will have disclosed developments and progress in automobiles for 1939. New styles of bodies, better engine performance, developments in gear shifting and other changes, all will have been under the gaze of the public. Criticism or credit, depending upon the whims and fancies of the motorist, will have been heaped on automobile designers in full measure.

How many of these same observers even stop to think of the tremendous engineering job that precedes the actual production of new models? Even at the recent low ebb in the business cycle, some of the larger automobile companies employed as many as two or three thousand men in engineering departments continuously working on creation and improvements. Months, even years, have been spent, for instance, on the new type of steering wheel gear shifts. It is safe to say, too, that hundreds of design and research men are at this very moment working on the next development along this line—gearless shifts—in order to provide something that will, in one, two or more years, outmode the then existing type and style of shift.

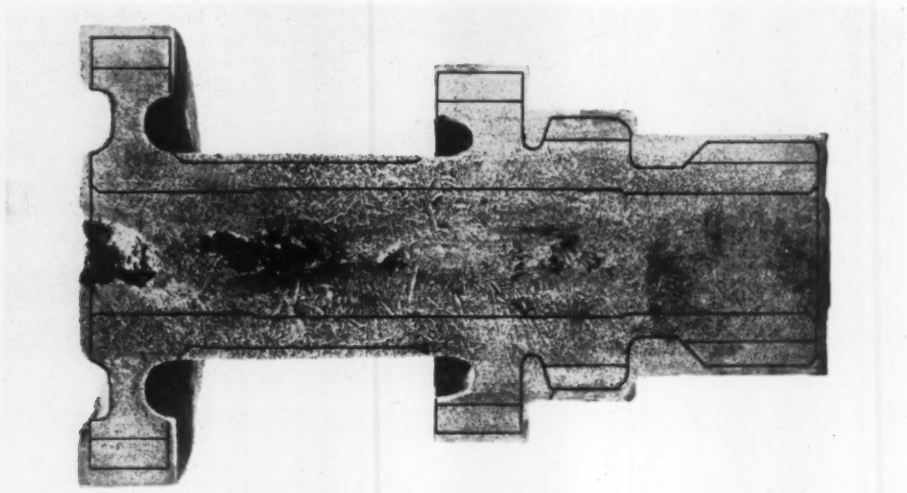
Cannot we all take a lesson from this never-ceasing activity in design? The automobile industry has been "down" in common with all others. But it always is one of the first to feel improvement in general business—to get its share, or more, of the buyer's dollar whenever an upturn starts. Machinery manufacturing companies and designers in general might well look to the methods of automobile concerns and ask themselves whether they too might not be able to improve their position on every upswing by increased efforts in development and design.

• • •

Peacetime Materials!

WITH peaceful settlement of the European situation apparently assured, the materials directory accompanying this issue takes on a somewhat changed significance. For several weeks during the final rush of compilation and listing, it had seemed that one of the most important uses of the directory might well have been made in the selection and purchase of materials and constructional machine parts for application in the design of equipment indirectly and directly engaged in the production of supplies for war purposes!

But with that crisis seemingly over, the directory is much more happily published with its original scope and purpose in mind. Chief engineers and designers in all types of machinery manufacturing plants will find in it a compendium of information relating to the materials available for use in the development and redesign of their machines. Months and months of intensive work have been expended in the revision of previously-published sections of the directory, and additional sections or listings have been added to make the complete book a technical guide that will be of inestimable service.



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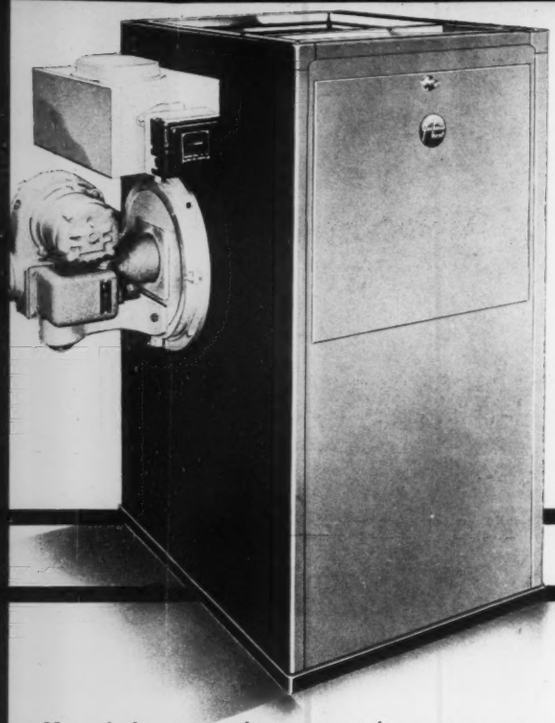
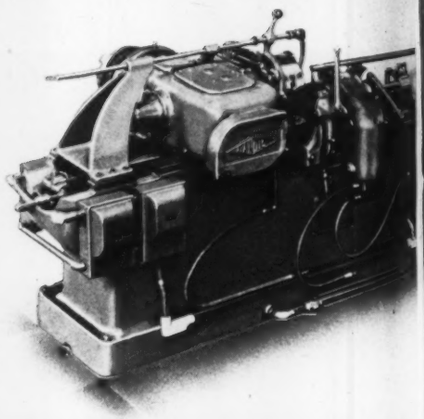


All-welded, one-piece construction of heavy gage copper bearing steel frame makes the York oil-fired air conditioning furnace, left, a compact, non-leaking "package" unit. Radiator sections are built from 1¼-inch steel tubes with spirally extended surface. Decorative casing is in luminescent gray



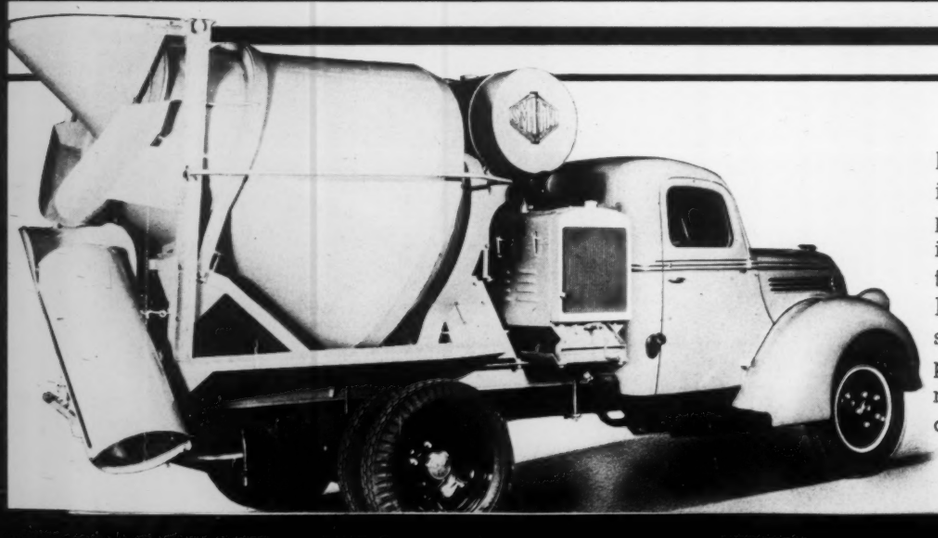
DESIGN FEATURES IN

Use of aluminum die castings for major parts of the Toledo scale, right, styled by Harold Van Doren, has reduced weight of unit from 50 to 13 pounds. Design entirely encloses lever mechanism, yet at the same time provides wide-spaced pivots for greater stability. Weight indicator travels one inch to the ounce

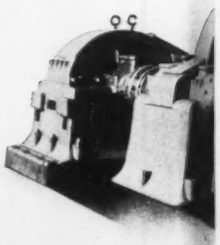
Granular finish on the Friez self-starting electric clock switch, below, gives it a neat and distinctive appearance. Clock motors operate on 20 volts from small transformers, and are built to run indefinitely without attention or lubrication

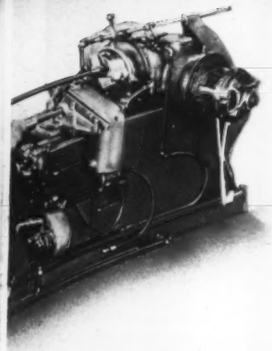
Welded steel plates enclose combination transmission and oil type clutch on the Smith mobile concrete mixer, below. Direct driven rotary turbine pump supplies water under 50 pounds pressure to batch as the drum is rotating, insuring a uniform mixture. Hardened steel is used for mixing blades

A PICTORIAL PRESENTATION WITH SPECIAL REFERENCE TO

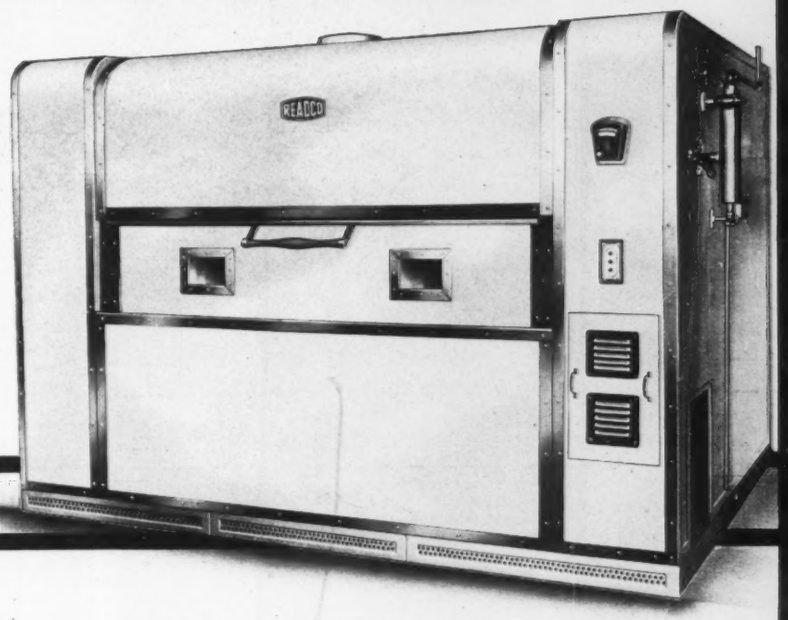


Designed to break down rubber in large volume, the Gordon plasticating machine, right, utilizes a heavy gray-iron cast frame to give strength and rigidity. Large rotor is driven by two sets of steel herringbone gears, powered by a 700-horsepower motor. Bearing, submerged in oil, takes thrust of approximately 300,000 pounds





Large gray-iron casting serves as substantial bed of the Lanhydro double-end threading machine, left. Flexible tubing enables hydraulically actuated threading units and ejectors to move free of other machine parts and give exceptional maneuverability

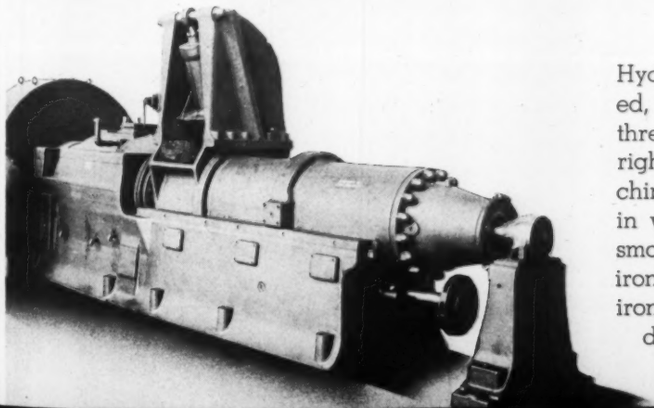


NEW MACHINES

Pyrex glass windows in the peel door of the Readco revolving tray oven, above, allow the operator to watch bake. Steel sheets bolted together and sealed with asbestos gaskets prevent steam leakage, and rock wool, eight inches thick, is used in wall construction, to give almost complete heat insulation

Landis Race-A-Way grinder, left, is completely devoid of attachments and control boxes, giving an unusually clean appearance. Concealed door hinges contribute to neatness. Motor wires are sheathed in lead cables to prevent deterioration of insulation from oil or coolant

OF RECENT MACHINERY
CHOICE OF MATERIALS



Hydraulic cylinder of close grained, nickel steel in the American three - way broaching machine, right, is built integral with machine ram, providing a long stroke in which weight of cylinder aids smooth and uniform cutting. Cast-iron piston head fitted with cast-iron rings adequately holds hydraulic pressure in cylinder

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Scanning the Field For Ideas

(*Continued from Page* 31)

as a preservative. This sealed glass envelope was then wrapped in glass tape and embedded in mastic compound for water and shock proofing. All segments of the outer shell, except the last, were screwed together and sealed with asphalt compound, the joints finally being peened out and burnished. The final section was shrunk fitted on tapered threads.

Molten Metal Can Be Pumped

TO MEET the demand for a dependable mechanism for pumping molten solder, lead and certain die casting alloys, the Ruthman Machinery Co. has made interesting modifications in the design of their motor driven gusher pump to enable it to cope with liquids having temperatures range from 600 to 700-degrees Fahr. and specific gravity about ten times that of water.

Because the pump originally was designed to handle water containing grit and abrasives, there are no packings, metal contacts or bearings in or near the liquid. Thus this original served as an excellent nucleus around which to design the modifications.

High heat naturally would injure the direct connected vertical motor and bearings if it should reach them to any considerable degree. This possibility is overcome by an ingenious "heat dispenser." This device, which can clearly be seen in the cut, *Fig.* 3, consists of a series of aluminum fans. These fans are

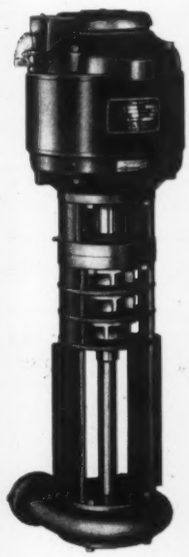

Fig. 3—Molten metal, including solder, lead and certain die casting alloys, are successfully pumped by this specially designed machine, the drive shaft of which is provided with a series of aluminum fans which prevent transmission of harmful heat to bearings and motor

LIKE ENCORES AT A NIGHT CLUB

DUMORE GIVES EXTRA PERFORMANCE

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The true test of a fine motor comes only after long hours of actual performance. Then is when the real trouper among motors earns the spotlight and the acclaim of users. So consistently have Dumore motors shown their ability to deliver smooth, quiet, unfailing power . . . long after it was "curtains" for ordinary motors . . . that they have won the preference of particular motor buyers.

There are many reasons why a Dumore gives this extra performance . . . these extra power hours per dollar. Into every unit goes 25 years of exacting manufacturing methods, proved and perfected by relentless research and fact-finding experience. (1) Armatures dynamically balanced to *eliminate vibration,* (2) commutator leads swaged by special Dumore process to assure 100% *electrical contact,* (3) commutators ground concentric with bearings for *longer brush life,* (4) armature windings expanded then *double sealed,* to *prevent centrifugal "breathing",* (5) motors inspected 5 *times* in manufacture; run-in to *seat brushes properly.*

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SPECIFICATIONS TYPE E MOTOR

Series (universal) 0-60 cycles; output, 1/30 h. p.; full-load speed, 7000 r.p.m.; amperes, .61; watts input, 70; duty, continuous; temperature rise, 40° C.; method of cooling, internal fan; bearings, composition bronze; housing, die cast aluminum; finish, natural; weight, 1¼ lbs.

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DUMORE MOTORS

FOR *Extra Power Hours*

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*Stocks carried.

OHIO GEARS

mounted on the vertical drive shaft within an open lantern-type housing made up of compartments separated by fins. Each of these fans dissipates a certain amount of heat which has traveled up the shaft, at the same time cooling the lantern arms and fins.

Neoprene Bearings in Core Drill

IN ORDER to assure perfect cores when sinking oil wells, the Reed Roller Bit Co. has designed a core drill having a nonrotating or floating type inner barrel and core catcher. This is depicted by *Fig.* 4. The inner barrel and core catcher do not turn with the drill, but remain stationary with the core there being no relative movement between the core and the catcher at any time.

Inasmuch as the outer barrel of the core drill rotates the bit in order to cut the core, an efficient bearing is required to prevent transmitting the rotary motion from the outer barrel to the inner barrel and core catcher. The design of this bearing presented a difficult problem since it can only be lubricated by the circulated fluid being used in the drilling operations. This fluid may be water, mud or oil depending upon the drilling position and condition of the sump. Types formerly used wore out rapidly and had to be adjusted frequently to accommodate for this change in position.

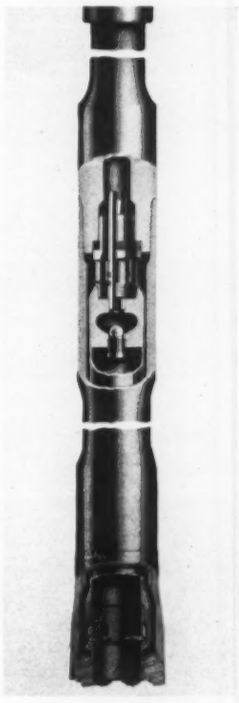
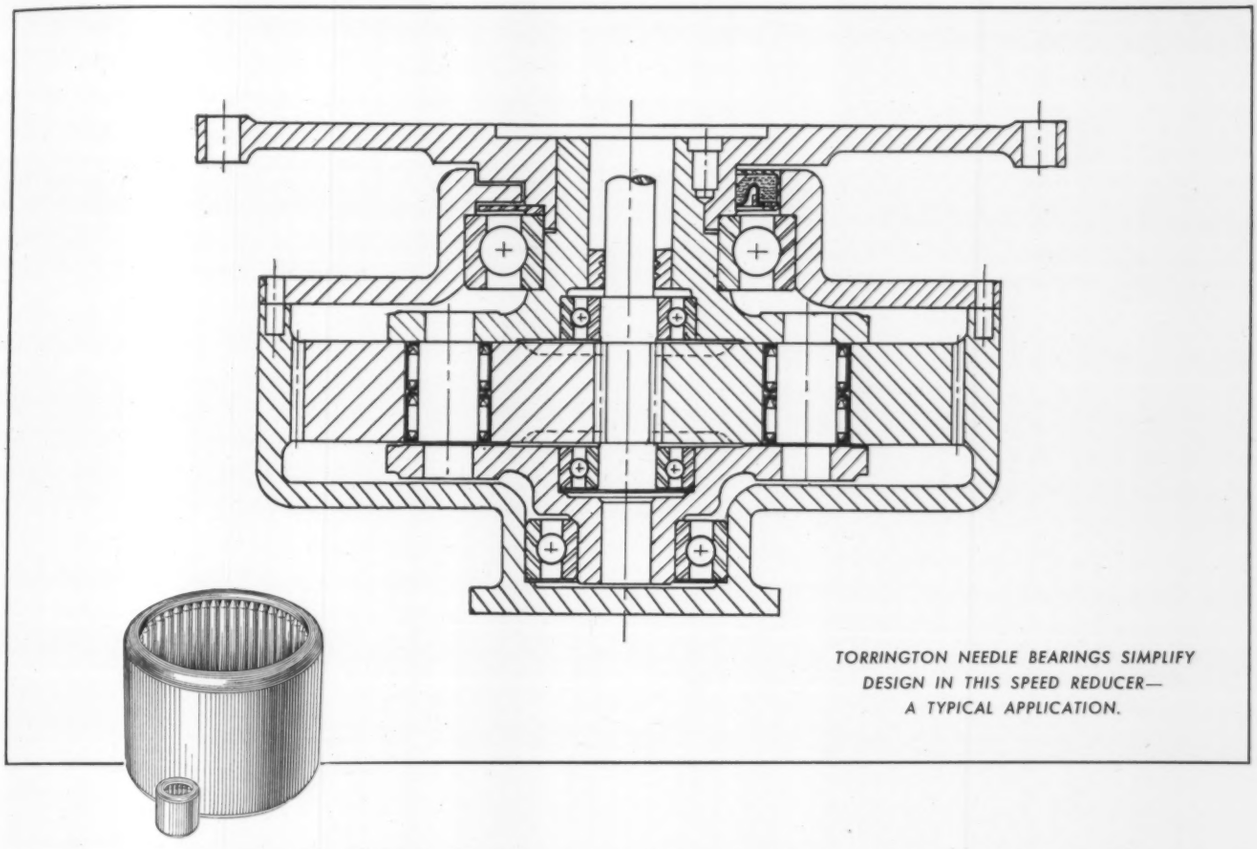


Fig. 4—Bearings of chloroprene rubber are used between the outer rotating body and the inner nonrotating or "floating" inner barrel of this core drill used for obtaining solid cores during process of drilling oil wells. These bearings cushion the core-catching device and at the same time resist deterioration by oil or water lubrication, and abrasion due to sludge

The problem was solved by the use of a du Pont neoprene bearing which could be lubricated by oil, water or sludge. With insured lubrication, wear on the bearing and barrel has been reduced to such an extent that frequent adjustments are eliminated.

TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES



TORRINGTON NEEDLE BEARINGS SIMPLIFY DESIGN IN THIS SPEED REDUCER— A TYPICAL APPLICATION.

COMPACT CONSTRUCTION SIMPLIFIES PRODUCT DESIGN

Effects Important Space Economies

THE COMPACT CONSTRUCTION of the new Torrington Needle Bearing aids materially in simplifying product design. The bearing requires only the simplest type of housing construction—a marked advantage where space is limited, as in the speed reducer illustrated. High radial load capacity—obtained by a full complement of small diameter needle rollers in a single retaining shell—permits the use of small sizes to take heavy loads.

The speed reducer illustrated shows how the important space saving advantages of the Needle Bearings have been successfully combined with the use of Torrington Ball Bearings.

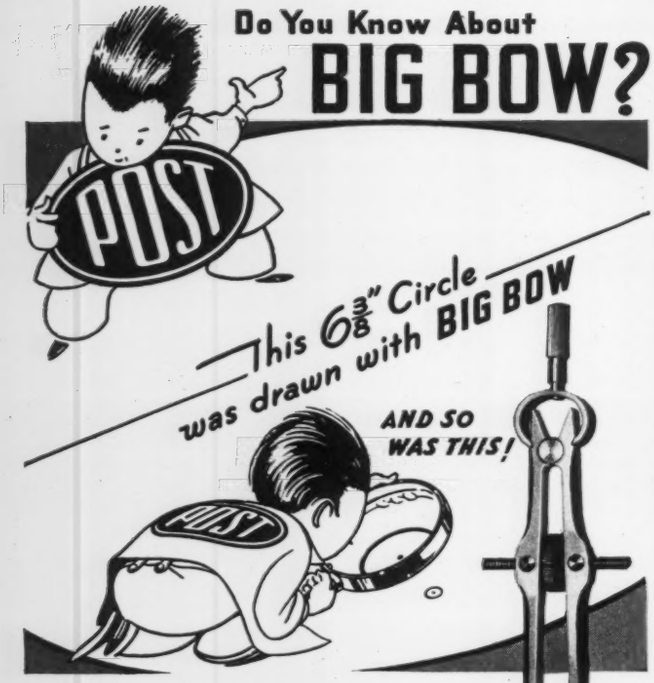
Needle Bearing Low in Cost

The Needle Bearing provides surprisingly economical anti-friction construction. Low in unit cost, it offers further manufacturing economies through its ease of installation and its simple housing requirements. It is ideally suitable for use in high-speed production processes.

Manufacturers considering the use of this new bearing in their products are invited to avail themselves of the experience of the Torrington Engineering Department in the laying out of bearing applications. Further information is given in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9. Specifications on Torrington Ball Bearings may be obtained by requesting Catalog No. 401.

TORRINGTON
NEEDLE BEARING

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities



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Ford Turns to Castings

(*Continued from Page* 38)

parts for machines, because it may suggest possibilities to designers who, while not directly concerned with problems of mass production, are vitally interested in new accomplishments with materials for incorporation in design.

Eclipsing all other developments at the moment is the work Ford is doing on centrifugal casting of certain production parts such as transmission cluster gears, ring gears, pinions and the like. The process of centrifugal casting as such is not new to foundries, since for years it has been applied widely to brake drums and other circular and cylindrical parts which benefit by the density and homogeneity of centrifugally cast iron, especially on outer surfaces. New however are the applications which Ford has developed.

For example, a transmission cluster gear casting can be produced with a considerable saving of metal over the former piece. Furthermore, as the photomicrograph in *Fig.* 1 shows, the metal in the part is homogeneous and dense exactly where these characteristics are needed, the center of the gear being completely bored out for the shaft. Thus, by using a centrifugal casting, Ford saves on cost and at the same time produces a better gear cluster.

In *Fig.* 2 is shown the equipment setup for centrifugally casting these parts. The casting "heads" containing the chrome-molybdenum steel molds and necessary cores are located at the outer rim of a large steel turntable. The turntable revolves slowly to bring the successive heads to pouring stations and discharge stations. Meanwhile the heads themselves revolve at speeds ranging variously from 600 to 800 revolutions per minute, depending upon the part cast.

TABLE II

Physical Properties, Test Bars

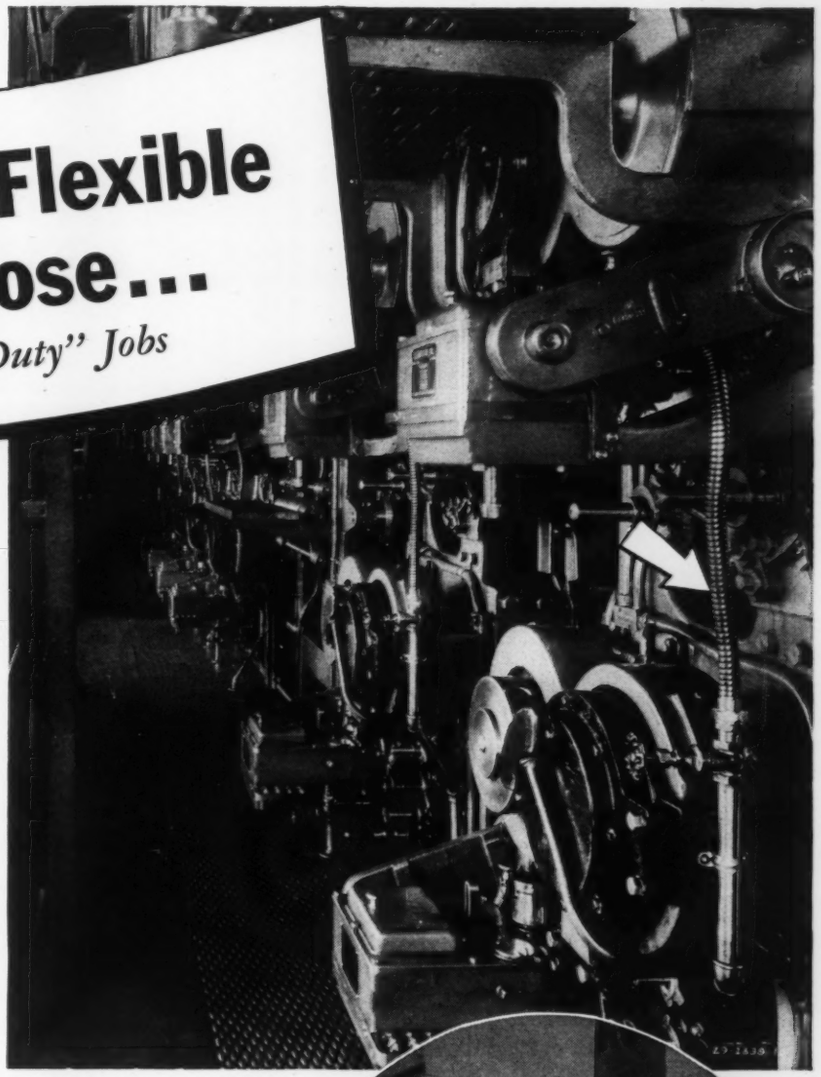
Type (see Table I)	Elastic Limit (lbs. sq. in.)	Tensile Strength (lbs. sq. in.)	% Elong. in 2 In.
No. 1	53,800	71,100	18.5
No. 2	56,500	78,000	16.5
No. 3	62,000	86,000	16.0
No. 4	65,120	90,750	15.2
No. 4 Hardened	108,150	128,620	10.0

Ford was one of the first to introduce the cast crankshaft and camshaft for automobile engines, devising a special analysis cast steel for this work, melted in electric furnaces and poured in vertical sectioned molds. The metal contains 1.35-1.60 per cent carbon, 1.50-2.00 copper, 0.85-1.10 silicon, 0.70-0.90 manganese, 0.40-0.50 chromium, with 0.10 and 0.08 per cent maximum phosphorus and sulphur respectively. Heat treated, the material shows a tensile strength of 120,250 pounds per square inch, 255 brinell hardness.

Table I shows the analysis and heat treatment details for several typical types of cast steel, and indicates the parts for which Ford uses the various materials. It should be noted that these are all cast steels,

American Flexible Metal Hose...

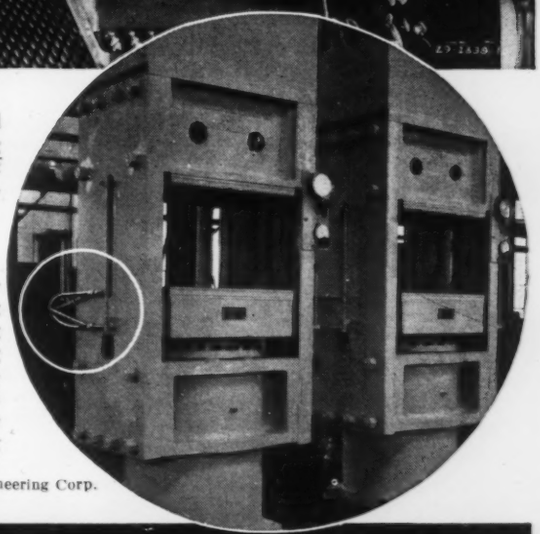
For "Heavy-Duty" Jobs



BEST insurance against constant servicing expense on flexible connectors or conductors is an installation of American Flexible Metal Hose. Whether specifications demand a simple conduit for wire protection . . . or a strong Interlocked Hose for reliable conveyance of mineral or vegetable oils, hot exhaust, tar, asphalt, steam or water . . . or the strongest, rustless, corrugated type *seamless* flexible tubing for connecting moving or misaligned parts while carrying liquids or gases under high pressures, there is a style of American Flexible Metal Hose or Tubing to meet the need.

Seamless Flexible Metal Tubing

Seamless Flexible Metal Tubing is ideal for dependable conveyance under pressure of air, fuel, oil or steam. Manufactured without welds, seams, joints, laps, or packing, of high tensile strength bronze, Monel or steel, it is 100% seamless—has no peer as industry's super tubing. That's why more and more designers of machinery and maintenance engineers are specifying "American Seamless". Do not hesitate to write us about your connector problems. Consultation with our engineering department entails no obligation. 38337



ABOVE—American Interlocked Steel Hose used for conveying lubricating oil to bearings of printing press in large newspaper plant.

• • •

RIGHT—American Bracketube used on Lake Erie Engineering Corporation's single opening hydraulic plastics molding press for carrying high pressure steam to movable platen. This patented device assures greater efficiency and longer service life.

Photo: Courtesy Lake Erie Engineering Corp.

American Metal Hose

ANACONDA
From mine to consumer

AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company

since the carbon content in all cases is under the 1.7 per cent figure.

Table II is in reality an extension of Table I and shows the physical properties of the above steels. Data given in these tables are from a paper presented by R. H. McCarroll of the Ford Motor Co. at a recent foundry conference in Ann Arbor, Mich. sponsored by the American Foundrymen's association. Illustrations herewith also are from this recent discussion of cast steels in automotive work.

The Saginaw Malleable Iron division of General Motors Corp. has been taking the initiative in extending the uses of malleable iron in automotive parts, with considerable success. Many engineers are of the opinion that the day is not far distant when General Motors cars will be using pearlitic malleable iron crankshafts exclusively.

In this connection an interesting example of evolution in the application of materials comes to mind. When pearlitic malleable iron was adopted for rocker arms in Buick and Chevrolet engines, it meant a loss of substantial business for the forge plant supplying these parts. Whereupon the forge people got busy and developed a new type of forged steel wheel hub which, especially in buses, showed numerous advantages over the previously used gray cast iron hubs. Meanwhile it was discovered that savings could be effected by switching from malleable iron to gray iron for differential housings, and the void thus created in malleable iron requirements for housings was at least partly filled by the perfection of the above-mentioned rocker arms.

Fig. 2—Mass production of centrifugal castings. Casting heads revolve on rotating turntable

Alert foundrymen are not missing any opportunities to capitalize on the development of improved cast irons and steels for industrial purposes. While their activities may not be attended with the publicity accorded other developments, nevertheless there is an unceasing movement toward better quality irons, with better strength and impact characteristics, more specific understanding of the function and cost of alloys in iron, and particularly concerted action in perfecting methods to control iron in the melting and pouring stage so that definite results can be assured in the properties of the castings.

This man has the proof

● When a Lewellen representative opens his portfolio on your desk a remarkable engineering story is revealed. Actual photographs show how Lewellen has solved many difficult speed control problems.

You'll agree that no better proof of Lewellen's leadership in the unusual applications of variable speed control could be presented.

You're interested because you know that efficient, regulated control of your production machines always means an **Improved Product at Lower Unit Costs.**

Is it a standard Lewellen Transmission that you need? Or, does your problem, like many others, entail design that demands the vast knowledge acquired by Lewellen engineers over a period of 40 years? *You will not be obligated for this special advice and counsel.*

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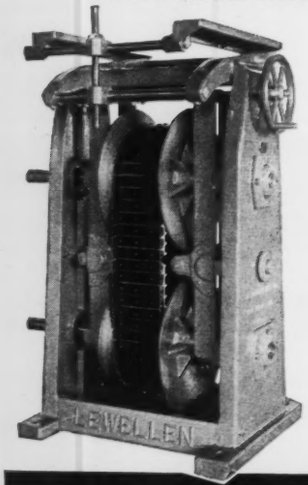

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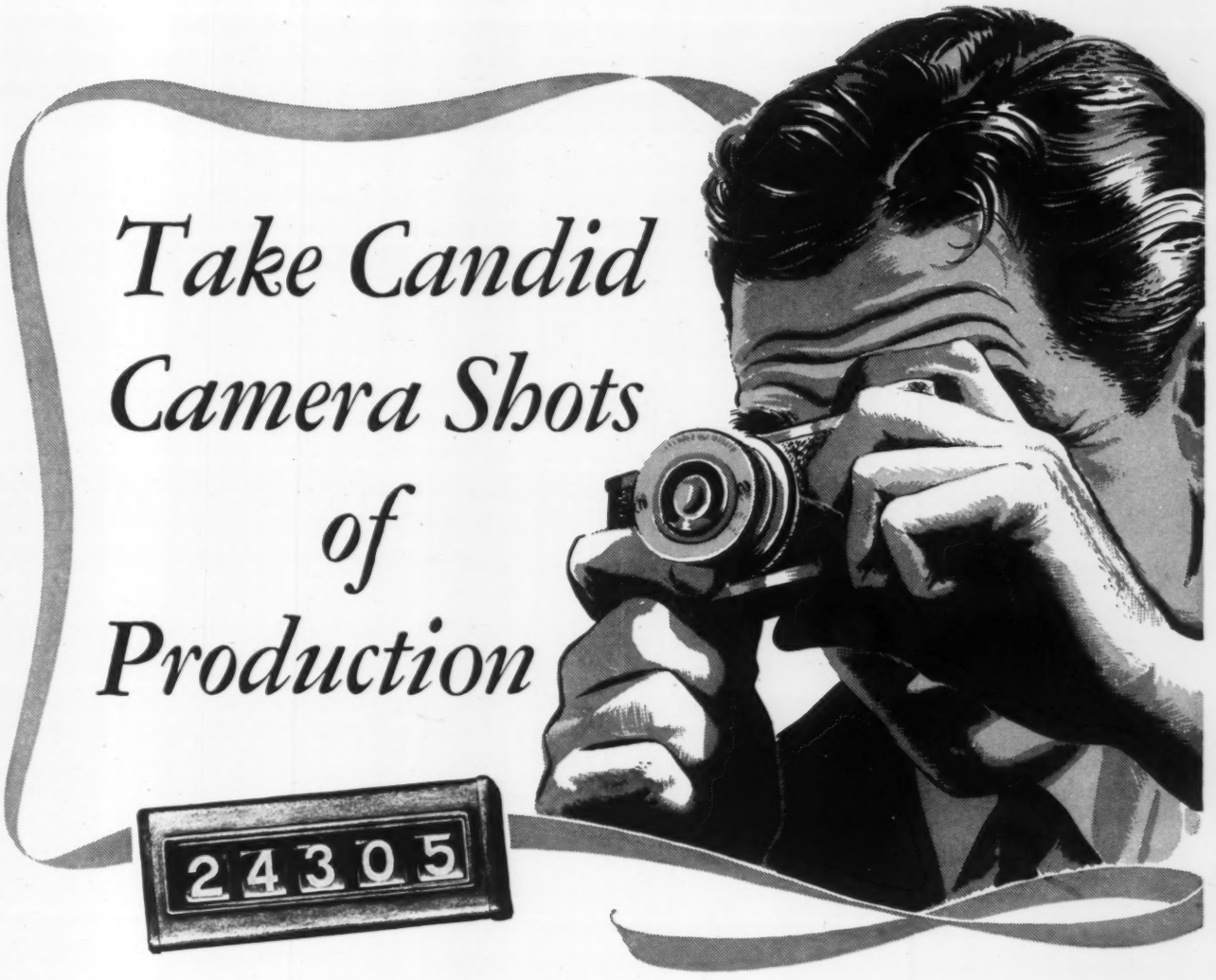

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Today, they want to see things as they really are—unposed, unaffected, true. And for this reason manufacturers of bottle fillers, conveyors, cutters, vending machines and many others are building into their products Veeder-Root Counting Devices—devices that count, measure, or record pieces, stops, lengths, volumes, operations—devices that give operators a quick, accurate picture of how much work their machines are doing.

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Baldwin-Duckworth drive from gear motor to agitator paddles in the mixing department of the Sherwin-Williams Co. (flooring removed to show drive)

Can you use an idea like THIS?

HOW else than with roller chain would you drive the agitator of this tank—with the very limited space available? Roller chain is the most versatile drive there is. It will work in any position — at slow or high speeds — efficiently — positively.

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BALDWIN-DUCKWORTH CHAIN CORPORATION
Springfield, Mass.
Factories at Springfield and Worcester

BALDWIN DUCKWORTH

Men of Machines

EDWARD L. MORELAND

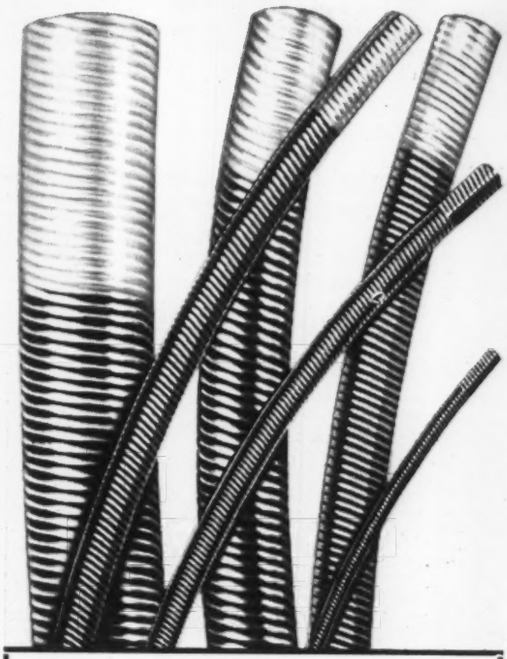
IN VIEW of his previous experience and having been head of the department of electrical engineering of Massachusetts Institute of Technology since 1935, Prof. Edward L. Moreland is well qualified to fulfill his new duties as dean of engineering of the Institute.

Prof. Moreland, born at Lexington, Va., in 1885, received his bachelor of arts degree from Johns Hopkins university in 1905, and his master of science in 1908 from M.I.T. After graduation he joined the engineering firm of D. C. and William B. Jackson, which later became Jackson and Moreland. This firm has directed many important engineering projects, and has contributed to the solution of various complex problems of power development and heat control in the petroleum industry, particularly in connection with efficient utilization of steam and generation of by-product power. During the war, he served as captain and later as major of engineers in the American Expeditionary Forces. His appointment as head of the department of electrical engineering came when he was chosen to succeed Professor Dugald C. Johnson.

CARL BREER

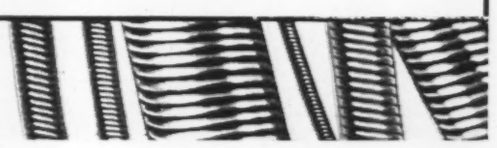
NOW executive engineer and member of the board of directors of Chrysler Corp., Carl Breer has directed research activities of the company since its founding, having been responsible, with his partners, for development of important automotive engineering improvements such as hydraulic brakes, floating power, redistribution of weight, modern streamlining, high compression engines and other features. He was co-designer of the

FIVE FACTS *about* FLEXIBLE SHAFTS



AUTOMOTIVE APPLICATIONS
S. S. WHITE FLEXIBLE SHAFTS

Radio Tuning Controls
Radio Antenna Control
Clock Hand Setting
Trip Mileage Resetting
Crank Case Drain Plug
(opening and closing)
Carburetor Choke and Needle Valve Control
Automatic Carburetor Control
Retractable Headlights
Speedometer Drive
Taximeter Drive
Truck Recorder Drive
Spot Light Control
Oil Filters
Windshield Wipers
Truck-Rail Freight Handling Device
Service Car Crane Drive
Engine Governor Control
Gear Shift Control
Headlight Tester



1. **TWO TYPES** — S. S. WHITE Flexible Shafts are made in two different types (a) for REMOTE CONTROL; (b) for POWER DRIVES. The former are made in diameters up to .437"; the latter, up to .750". Each type was specially developed for its particular field of service and is available in a selection offering a wide range of physical characteristics.

2. **SIMPLICITY** — The flexible shaft is unquestionably the simplest means for mechanical remote control or for the transmission of power. A single, self-contained, easily applied unit, it bridges the gap between any two points, regardless of their relative positions.

3. **ECONOMY** — The extreme simplicity of the flexible shaft is the keynote to its economy. Its use often eliminates extra parts, and avoids the need for accurate alignment of connected parts, thereby reducing manufacturing and assembly costs.

4. **RELIABILITY** — For many years S. S. WHITE Flexible Shafts—millions of feet of them—have been used with unqualified success in the Automotive, Radio, Airplane, Machine Tool and many other industries. Their unfailing performance on speedometers and airplane tachometers alone, has established their reliability beyond question.

5. **ENGINEERING AID** — Always available, without obligation, to help you select the right shaft for a given remote control or power drive and to work out application details. Write us.

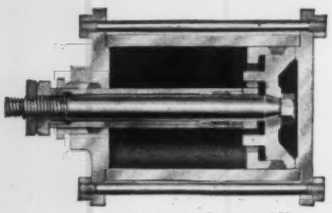
Write for a free copy of ENGINEERING BULLETIN 38 covering Flexible Shafts for Remote Control and their application.

S. S. WHITE

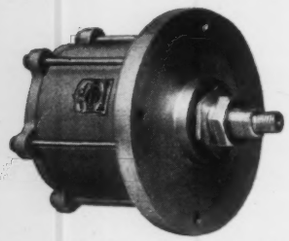
The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
Department R, 10 East 40th St., New York, N. Y.

Sustained High Efficiency

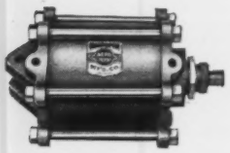
Air Cylinder Operation



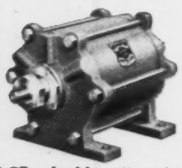
Sectional View



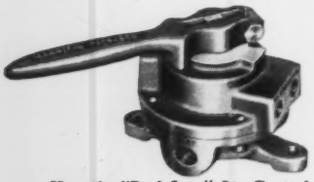
Model JR—double acting air cylinder



Model BR—double acting air cylinder



Model CR—double acting air cylinder



Hannifin "Pack-Less" Air Control Valves available in all types for positive control of air operated equipment

Hannifin "Leakproof" Air Cylinders provide maximum power and eliminate leakage troubles, for the high efficiency piston seal is easily maintained throughout the entire life of the piston packing. The soft, graphite treated piston packing is adjusted from the outside, without disturbing any other parts, simply by loosening the lock nut and turning the adjusting nut and tube. Perfect piston fit in a ground and honed cylinder bore means high efficiency operation.

Hannifin "Leakproof" Air Cylinders are built in a complete range of standard mountings, sizes 1 to 16 inch bore, for any length stroke. Larger sizes built to order. Single and double-acting types with air cushion at either or both ends if required.

Write for Bulletin 34-MD with complete specifications.

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Engineers • Designers • Manufacturers • Pneumatic and Hydraulic Production Tool Equipment

HANNIFIN

IMPROVED AIR CYLINDERS

first Chrysler automobile.

Actively engaged in automotive research since his high school days, Mr. Breer built one of the first steam cars on the West Coast before he was 17 years old. After graduating with a mechanical engineering degree from Leland Stanford university, he served a three-year apprenticeship at Allis-Chalmers Co., later joining the Moreland Distillate Truck Co. Two years after he organized Acme Electrical Auto works, and in 1916 he joined Fred M. Zeder to become research engineer for Studebaker Corp. With Mr. Zeder and Owen R. Skelton, his present partners, he allied himself with Willys Corp., the following year, organizing a consulting engineering service, which in three years transferred its activities to the Maxwell Motor Car Corp.—Mr. Breer becoming executive engineer. In this same capacity and that of director of research he joined the Chrysler Corp. in 1925. In addition to his duties mentioned above, he also is vice president of Airtemp Inc. and vice president and director of the Chrysler Institute of Engineering.

C. H. PHELPS has recently joined Weaver Mfg. Co., and assumed duties in the engineering department.

♦ ♦ ♦

WILLIAM H. PRICE JR., of Carrier Corp., has recently been elected president of Air Conditioning Manufacturers association.

♦ ♦ ♦

R. K. JACK, veteran engine designer, has joined the engineering staff of Reo Motor Car Co., in charge of the company's engine department.

♦ ♦ ♦

WILFRED PAQUIN has been added to the research staff of Ferro Enamel Corp., Cleveland, to study properties of domestic clays as to their suitability for use in porcelain enamel.

♦ ♦ ♦

SAMUEL P. LYLE, extension agricultural engineer, United States Department of Agriculture, has been inaugurated as president of the American Society of Agricultural Engineers.

♦ ♦ ♦

GEORGE H. DUNCOMBE JR. has joined the staff of Battelle Memorial institute, Columbus, O., and has been assigned to research in ceramics. Mr. Duncombe was formerly engineer with the National Aluminate Corp.

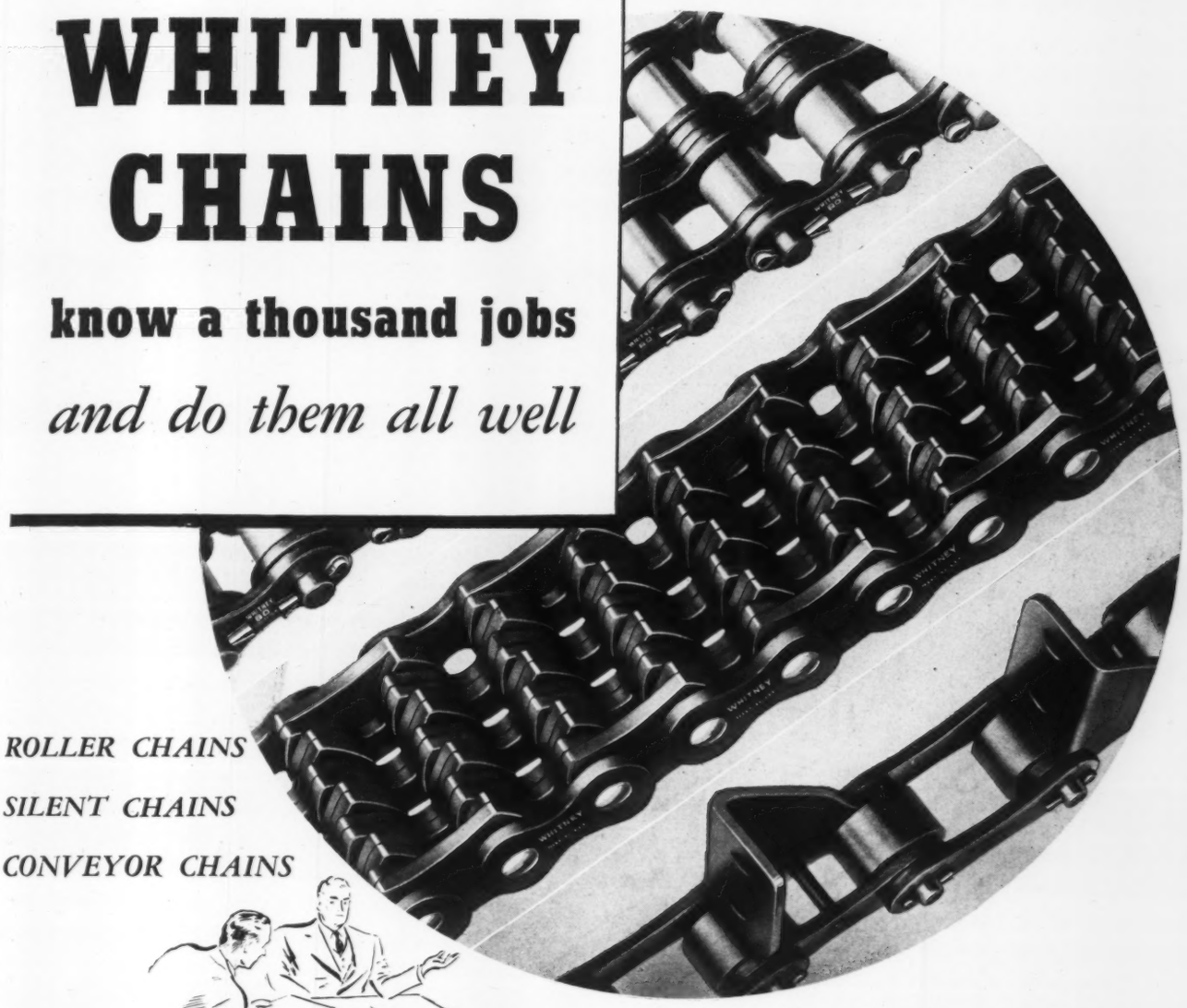
♦ ♦ ♦

J. C. BARNABY, previously manager of Worthington Pump & Machinery Corp.'s oil and gas engine application division at Buffalo, and responsible for engine sales in the central division, has been placed in charge of special engineering work covering engine research and design, to which he will devote his entire time and activity.

WHITNEY CHAINS

know a thousand jobs

and do them all well



ROLLER CHAINS

SILENT CHAINS

CONVEYOR CHAINS

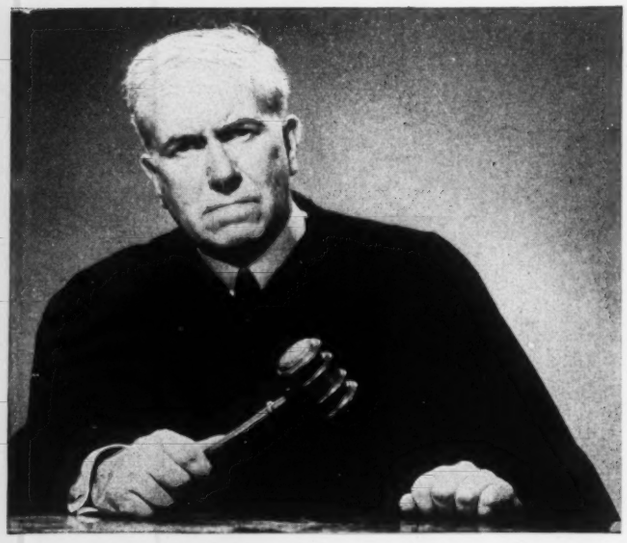
On every chain drive job—big or small—standard or special—low speed or high speed—you can rely on Whitney chains to do a long, honest job of keeping production on the mark, year after year.

Machine designers and builders value this assurance. They know that for 40 years Whitney chains have been used on leading machines in all types of industry—that the name Whitney carries weight with careful buyers. This long-standing acceptance among manufacturers more than justifies your investigating the application of Whitney chains to your problems.

Write for complete catalogs on Whitney roller, silent, and conveyor chains, sprockets, and flexible couplings.

The **WHITNEY** *Chain & Mfg. Co., Hartford, Conn.*

"If it pleases THE COURT..."



May we respectfully submit the case of "Castell" Drawing Pencil in the Court of Public Opinion?

We maintain that "Castell" is the finest drawing pencil money can buy.

We maintain that "Castell" is milled by the exclusive microlette process . . . that it has a graphite particle purity between 99.5% and 99.8%.

We maintain the "Castell" lead is free of all impurities... grit and hard spots... that it does not scratch, flake, smudge or crumble. That its point resists unusually hard pressure without snapping off. That it is absolutely accurately graded in 18 uniform degrees, 7B to 9H.

May we recommend that *you* act as both judge and jury to see if you agree with the verdict already rendered by craftsmen everywhere—that ***"Castell" is the world's standard of quality.***

"CASTELL"
DRAWING PENCIL ★ 15c
IN THE METAL BOX

The highest priced drawing pencil sold in America.
MADE IN BAVARIA

No Grit
No Scratch
No Smudge

A·W FABER·Inc. NEWARK, N. J.

NEW Materials and Parts

Copy-Making Machine

WATERPROOF, smudgeproof copies, like photostats, of anything drawn, printed, written or typed on a flat surface may be made in three minutes with the Zenograph machine just placed on the market by the Reproduction Equipment Corp., 11 Broadway, New York. Zenograph is especially recommended for copies of blueprints, charts, letters, and layouts. An outstanding feature is the pneumatic top,

Anything printed or written may be copied with a new Zenograph machine which is recommended for reproducing blueprints and charts

which insures perfect contact. The illustration shows a Zenograph which occupies about the same space as an ordinary office desk. It is mounted on legs which are removable for shipping. Width is 26 inches, length 46 inches with shelves down, 90 inches with shelves in place. Cabinet has a speckled bronze-like finish.

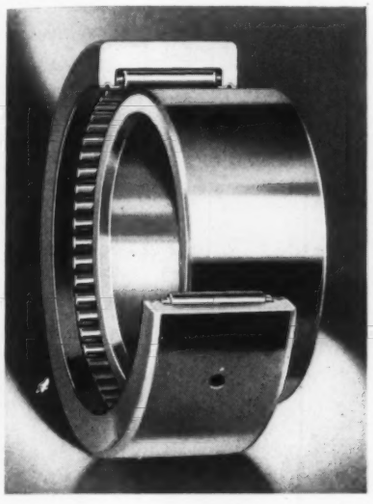
Standard Quill Bearings

NEW type of heavy duty needle roller bearing known as the standard quill bearing has been announced by Bantam Bearings Corp., South Bend, Ind. The ordinary assembly of outer race with hardened retaining rings, washers, stampings, etc., has been supplanted by a one-piece, rigid, channel-shaped outer race in which a full complement of small diameter rollers is firmly held. A spring steel band is

(*Continued on Page* 57)

(*Continued from Page* 54)

employed to maintain the rollers and outer race as a unit during assembly but does not carry any load while operating. The rigid rib surfaces of the outer race are accurately hardened and ground, thereby

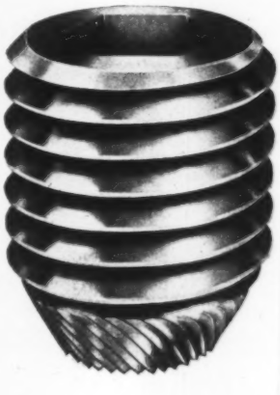


A rigid, one-piece outer race holds a full complement of small rollers in this standard quill bearing

keeping rollers in perfect alignment. Rollers are correctly proportioned to the pitch diameter involved and are made with husky curvilinear trunnions. The standard quill bearings are carried in stock for shafts from ¾ to 5 inches.

Knurl-Pointed Set Screws Grip Shaft

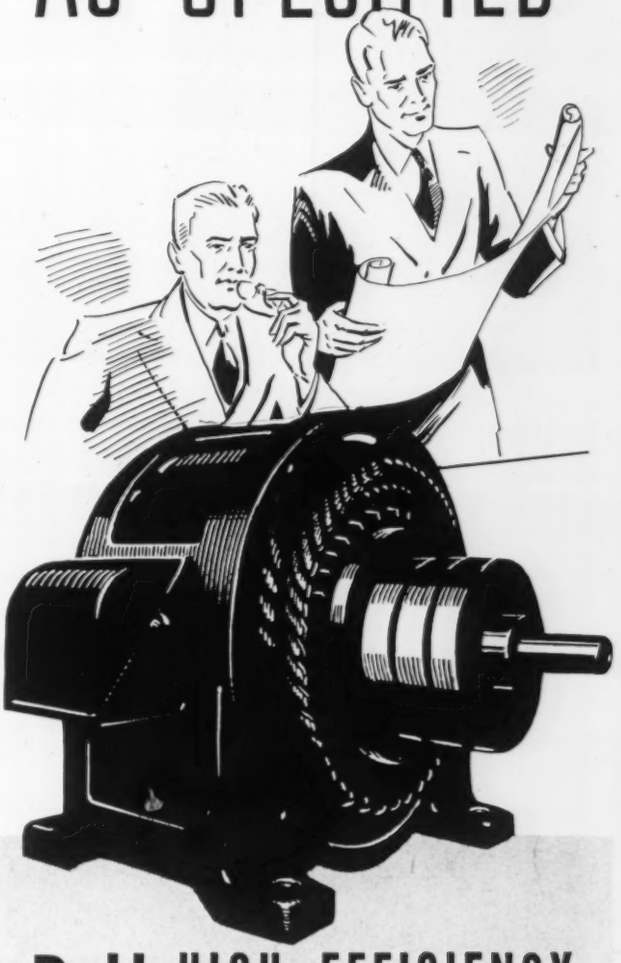
CUP point set screws with knurling all around the points are available now through Standard Pressed Steel Co., Jenkintown, Pa. When turned into place the knurled edges effectively grip the shaft



Knurled edges on these cup point set screws grip the shaft so effectively that loosening or backing-off is impossible without using a wrench

in such a manner that loosening or backing-off is impossible except by the application of a wrench. Since the screws do not harm the threads of the tapped holes it is possible to re-use the same screws in the

"AS SPECIFIED"



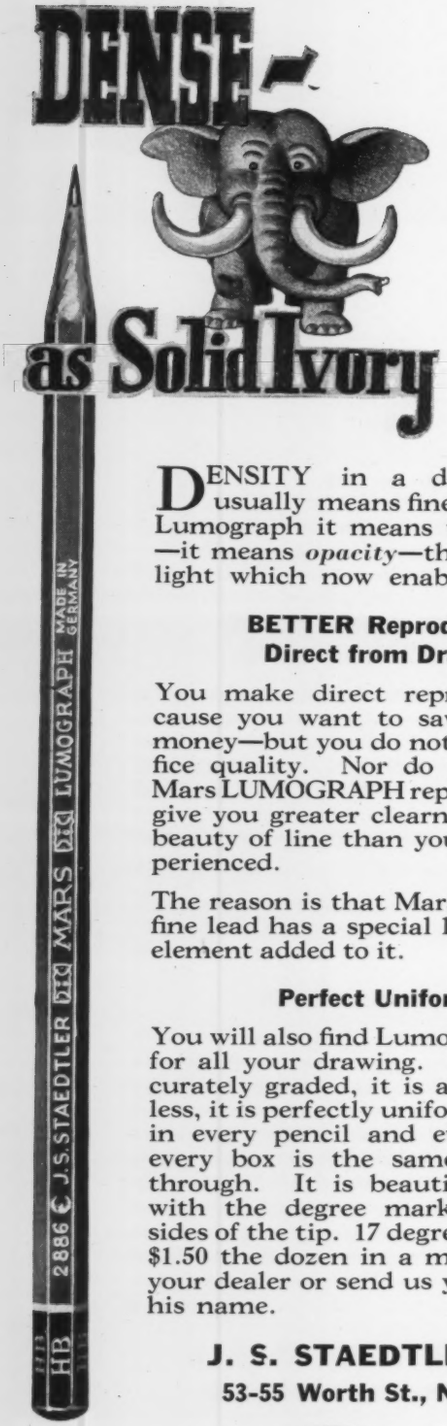
P&H HIGH EFFICIENCY ELECTRIC MOTOR

You'll find good reason why the standard specifications of many large, nationally-known manufacturers call for P&H High Efficiency Electric Motors. Their record of reliable performance has helped to win an enviable reputation for many products as well as all sorts of special installations. So dependable is the performance of these motors, that the total cost for service and repairs is less than 1% of gross sales — a record which is outstanding in the industry. P&H motors "As Specified" in your applications will assure the same dependable service. . . . The Harnischfeger Corporation, 4556 West National Avenue, Milwaukee, Wis.

Convertible Slip-Ring and Squirrel-Cage Motors up to 250 h.p. capacity. Literature on request.

HARNISCHFEGER CORPORATION

MOTORS • HOISTS • WELDING ELECTRODES P&H ARC WELDERS • EXCAVATORS • ELECTRIC CRANES



DENSITY in a drawing pencil usually means fine lead. In Mars Lumograph it means that and more—it means *opacity*—the resistance to light which now enables you to get

BETTER Reproductions Direct from Drawings

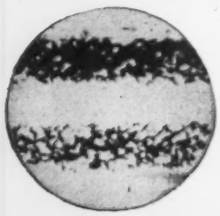
You make direct reproductions because you want to save time, work, money—but you do not want to sacrifice quality. Nor do you need to—Mars LUMOGRAPH reproductions will give you greater clearness, sharpness, beauty of line than you have ever experienced.

The reason is that Mars Lumograph's fine lead has a special light absorbing element added to it.

Perfect Uniformity

You will also find Lumograph superior for all your drawing. It is most accurately graded, it is absolutely gritless, it is perfectly uniform—every lead in every pencil and every pencil in every box is the same all the way through. It is beautifully finished, with the degree marked on all six sides of the tip. 17 degrees—15c each—$1.50 the dozen in a metal box. Ask your dealer or send us your order and his name.

J. S. STAEDTLER, Inc.
53-55 Worth St., New York



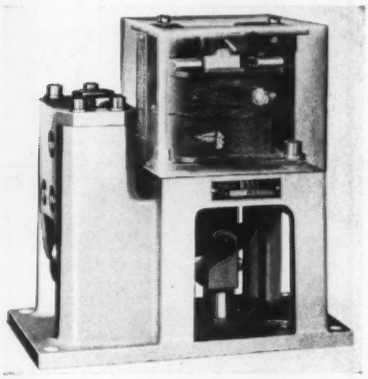
Photomicrograph of Lumograph line (upper), and other drawing pencil (lower); Proving Lumograph's superior opacity.

MARS LUMOGRAPH

same holes indefinitely and to obtain an equal degree of self-locking protection. A wide range of sizes is available.

Solenoid Controlled Air Valves

TWO solenoid-controlled air valves, especially designed for high-speed service such as that required for welding operations, have been announced by Ross Operating Valve Co., 6499 Epworth boulevard, Detroit. One unit is for the control of single acting and the other for control of double acting cylinders.



Poppet valve principle is used in solenoid-controlled air valves for controlling single and double-acting cylinders

The poppet valve principle is used in both models and they are compactly designed and made light in weight. Utilization of air line pressure for reversing the valve action is an unusual feature and the elimination of return springs makes possible the use of smaller solenoids. Valve proper or solenoid part is removable from valve body by simply loosening four bolts.

Pre-Assembled Lock Washer, Screw

A PRE-ASSEMBLED lock washer and standard machine screw, known as "Sems", is the latest addition to the line of metal fastenings made by Shakeproof Lock Washer Co., 2501 North Keeler av-

Each screw in this pre-assembled unit is equipped with the correct size of lock washer, which cannot drop off

enue, Chicago. The fastening offers better product control because each screw is equipped with the cor-

Acknowledgment

MACHINE DESIGN takes this opportunity of thanking all those companies and individuals who cooperated in the compilation of the directory of engineering materials which is stitched into the center of this issue. We are particularly indebted to the manufacturers of the materials for their response to requests for information on their products, and to the advertisers whose collaboration made possible the presentation of the materials directory.

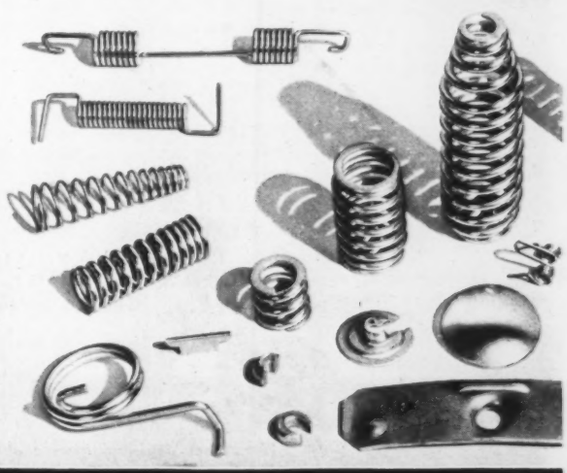
Photo courtesy The Heald Machine Co.

AVIATION'S NEW TYPE OIL LINE HOSE NOW ADAPTED TO MACHINE TOOL APPLICATIONS

Several leading machine tool builders now specify AVIOFLEX. Completely impervious internally to hot hydrocarbon fluids due to use of laminated cellulose sheets wrapped over a specially profiled flexible metal core. Also resistant externally to hot oils. AVIOFLEX construction assures great strength, practically unlimited flexing life. Data, sample, on request.

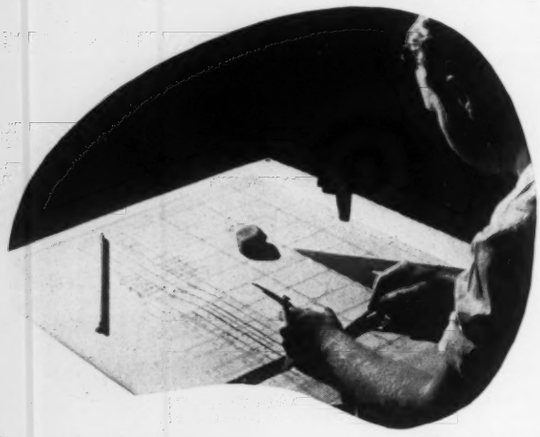
CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS

"It is a Raymond policy to investigate new materials and methods which appear to promise improved spring performance"



RAYMOND SPRINGS
RAYMOND MFG. CO.
DIVISION OF ASSOCIATED SPRING CORPORATION
280 So. Centre St. - - - CORRY, PA.

More than merely a better method of making bl - - - white prints



Ozalid savings actually begin on the drafting board!

The advantages of the Ozalid Process are not limited to the final production of prints, but actually begin on the drafting board!

How? The exclusive dry-developing feature of the Ozalid Process provides, for the first time, a simple and certain method of making transparent duplicates on either cloth or paper, directly from the original tracing and without the use of negatives.

That the use of these transparent duplicates will effect substantial savings in drafting time is attested by reports from hundreds of users . . . reports similar to the following . . .

"cuts drafting costs in half"

"Where one drawing is similar to another, we make an Ozalid Transparent Duplicate, then draw in any changed part or parts and use this as a master tracing to save drafting time and avoid the mistakes that often occur in marking up blue prints.

"We also use the process in the preparation of new drawings by first making an Ozalid Transparent Duplicate on cloth and using this for reference and for duplicate prints. All changes are made on the Ozalid Duplicate as the original drawing is filed away until such time as the Ozalid Duplicate is worn out or a new one is needed because of numerous changes.

"This saves us money in redrawing and is half the cost of the 'ink reproduction' method previously used."

You, too, can save time and money by using the Ozalid Process, for its advantages apply to practically all types of drawings used in product design and engineering. Investigate this modern method of making white prints with either blue, black or maroon lines.

Ozalid
TRADE MARK REG. U.S. PAT. OFF.

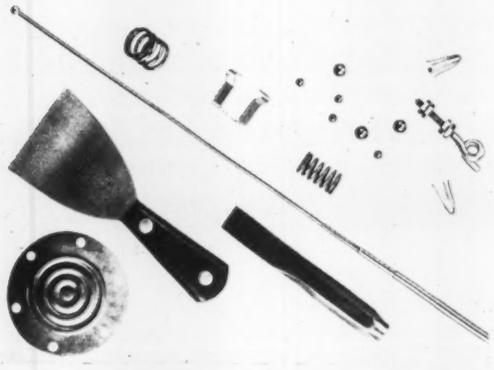
OZALID CORPORATION
354 Fourth Avenue,
New York, N. Y.
Please send printed matter about the Ozalid Process, together with prices and samples of Ozalid White Prints.

Name .....
Company .....
Street .....
City ..... State ..... MD 10-38

rect size of lock washer for its particular type of head. Moreover, since the lock washer cannot drop off, no screw can be applied without a lock washer under the head. Preliminary tests in large and small production plants have indicated these assembled units not only save costs, but give faster, better production.

High Tensile Nickel Alloy Developed

INTRODUCED as "Z" nickel, an alloy, 98 per cent nickel, having a strength from 2½ to 4 times that of ordinary structural carbon steel has been developed by the International Nickel Co., Inc., 67 Wall street, New York. It has been produced with a tensile



Tensile strength several times greater than that of ordinary structural carbon steel is found in new nickel alloy which fabricates easily

strength as high as 250,000 pounds per square inch and a hardness value of 46 Rockwell C. In its unhardened or annealed condition, it fabricates almost as easily as pure nickel. The metal can be heat treated after fabrication with little if any distortion since heat treating operations are carried out at temperatures from 890 to 930 degrees Fahr. The alloy is produced commercially as hot rolled or cold rolled strip in a wide range of sizes and in various tempers. Illustrated are typical examples of parts made from Z nickel alloy.

Fractional Horsepower Motors

FOR a variety of high-speed applications requiring a particularly well balanced armature, fractional horsepower motors, types W and W2, have been developed by the Dumore Co., Racine, Wis. Largest and most powerful of the Dumore line, they are also among the most efficient. They range from 1/3 to 2/3-horsepower. High precision, grease-sealed ball bearings are mounted in steel sleeves molded in the aluminum housings. Preloading springs eliminate end play and compensate for wear. Line leads are

Take a Tip from Wilson!

G-E UNDIVIDED RESPONSIBILITY GIVES WILSON

ONE SOURCE FOR ALL ELECTRIC EQUIPMENT

Relying on General Electric not only saves Wilson's time but also assures his obtaining electric equipment with matched electrical characteristics—equipment designed to operate as a unit.

Moreover, no matter where Wilson's machines may go, his customers will find a G-E service shop nearby for all types of electric equipment.

SOMEHOW, Wilson's never all tied up with a lot of details. He's one machinery manufacturer who is free to devote his time to important problems. A wise delegation of responsibility, he has found, leaves him time for bigger things—for contacts or broad design and sales problems.

Take the electric equipment on his machines, for example. Instead of groping through a maze of details in trying to co-ordinate many makes of electric equipment, Wilson leaves all the electrical details to one manufacturer. He delegates to General Electric the undivided responsibility for the electrical end of his machines.

Delegate the Responsibility

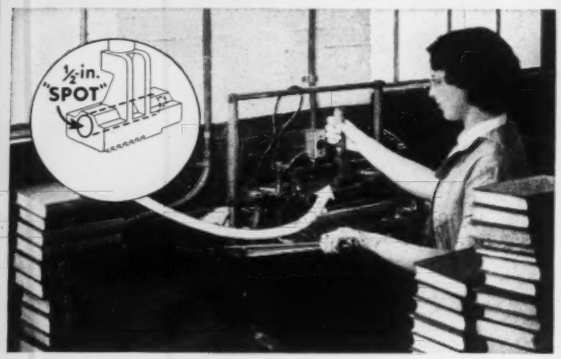
If you're ever harassed by trying to work out electrical details, take a tip from Wilson and try letting our engineers help you co-ordinate the electric equipment.

We don't claim that as a result you'll have every afternoon free for a golf match. But maybe you will have at least a few more hours to devote to your major design or sales problems. A phone call will put you in touch with a sales engineer in our nearest office. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

011-367

GENERAL ELECTRIC HEAT BOOSTS OUTPUT 25 PER CENT



BY providing heat in a small, hard-to-reach part, a General Electric heating unit materially increased production of a Dek-O-Letter machine.

The machine is used in the Schiller Book Bindery, San Diego. Users like electric heat built into their equipment. L. B. Becker, proprietor, writes that, in addition to increased production, electric heat has given uniformity impossible before and greatly reduced costs because the heat is exactly where needed.

General Electric heaters are high-resistance coils packed in a heat-transferring agent and sealed against wear and oxidation by a heat-conducting, corrosion-resisting metal. This is the widely known Calrod construction. It assures long, dependable service in any kind of heating job.

Immersion heaters are made for all kinds of liquids. **Strip heaters** are made for convection or radiation heating of machines. **Cartridge units,** like the one installed at the Schiller Book Bindery, are made for heating restricted areas.

Fill out and mail the coupon for a free catalog compiled by heating experts and containing descriptions, diagrams, prices, sizes, and ratings of all General Electric heating units.

SEND THIS COUPON TODAY

General Electric, Dept. 6B-201
Schenectady, N.Y.

Please send me full information about General Electric heating units (GED-650).

Name.....

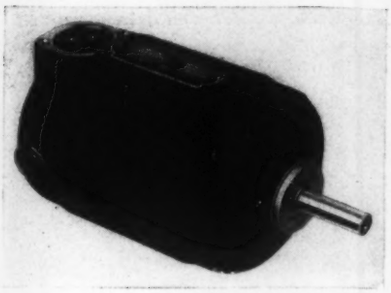
Address.....

City.....State.....

160-74

GENERAL ELECTRIC

not brought outside the motors but to two-pole male connectors mounted in the housings. The motors are

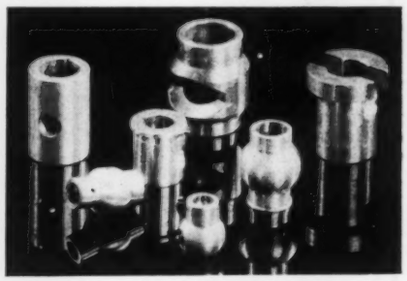


Preloading springs eliminate end play and compensate for wear in new fractional horsepower motors

of the plain series, universal type, operating on alternating and direct current, and have a varying speed characteristic.

Announces Self-Lubricating Bronze

IMPARTING many unusual and valuable properties to bearing metal, a material, known as "Ledaloyl" self-lubricating bronze has been developed by Johnson Bronze Co., Dept. M, 525 South Mill street, New Castle, Pa. Ledaloyl can be classified, primarily, as a sintered type. However, an exclusive process of pre-alloying the basic metals gives characteristics never before available. For instance, it permits the introduction of lead. This element eliminates harsh-



These are typical bearings made from a new self-lubricating bearing bronze which is pre-alloyed

ness and provides for mis-alignment. Likewise, pre-alloying reduces all the basic metals to one definite alloy, thus creating a uniform grain structure and a thoroughly homogeneous material. Because of the porous character of the bearing a large volume of oil is retained after the bearing is submerged in oil, thus providing a lubricating medium to the shaft when needed. The illustration shows several parts made of Ledaloyl.

Photoelectric Relay Control

DESIGNED for general purpose control, the model 50 photoelectric relay complete with light source has been placed on the market by United Cinephone Corp., Thirty-third street at Queens boule-

CASE STUDIES OF CO-OPERATION IN BUILDING BETTER MACHINES—NO. 7

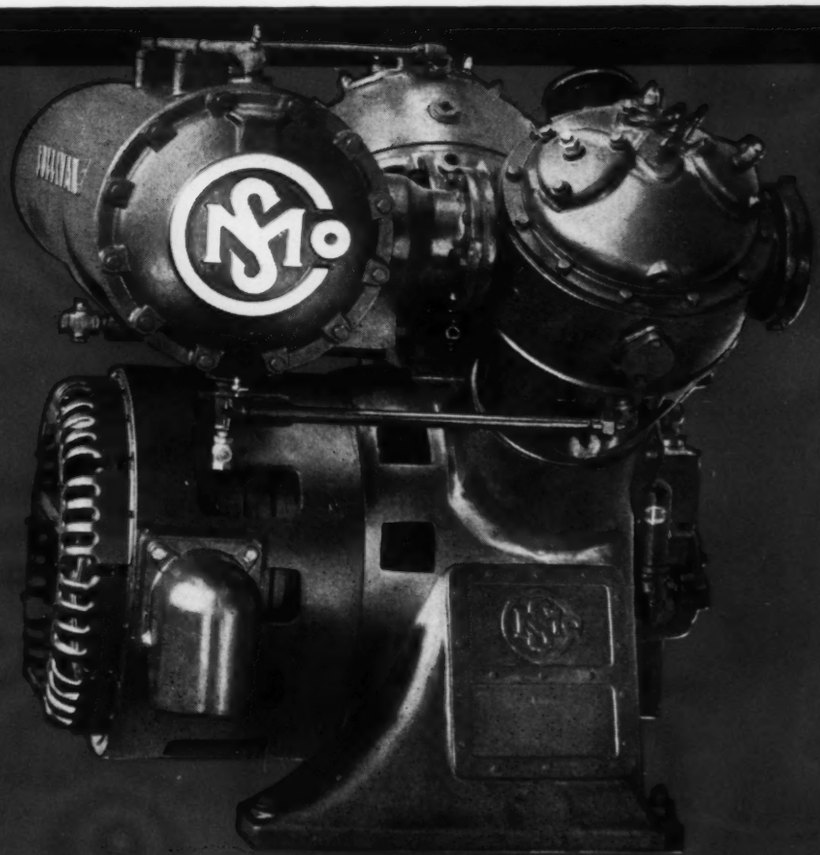
HOW G-E *Motors*

Help Build Compactness and Performance into Sullivan Compressors

IN THE selection of the electric drive for its heavy-duty compressors, the Sullivan Machinery Company sought especially for efficiency, simplicity, and reliability. Compactness and an attractive appearance were also desired.

G-E motor engineers, co-operating with the designers, were able to determine the right type of motor for the machine, and General Electric was able to furnish the drive that met exactly the requirements desired. Thus, overmotoring and misapplication were avoided, and this highly efficient, compact compressor unit driven by a built-in motor was the result.

You'll find it very profitable in your machine-design program to take advantage of General Electric's complete service, which makes possible a unit of modern design, greater manufacturing economy, and ready customer acceptance. General Electric can supply the right motor for every requirement, and G-E designers and engineers will gladly work with you in determining the correct solutions of your electrical problems. General Electric Co., Schenectady, N. Y.



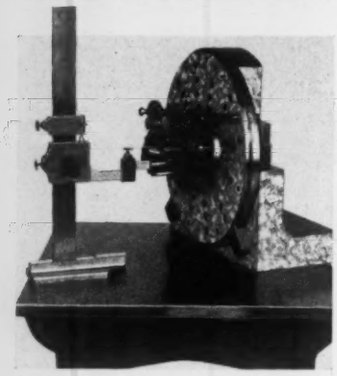
A two-stage, V-vertical Sullivan compressor with a built-in 100-hp G-E synchronous motor

GENERAL ELECTRIC

Filing No. 8058

020-359

When ACCURACY is PARAMOUNT use the PESCO INDEX MASTER



✱ *This simple checking device will measure work to .00005 inches*

● Here—for the first time—is a speedy and accurate instrument for making layouts and checking measurements to tolerance of .00005 inches. It is quickly adaptable to layout, model and tool-making, as well as to close inspection of production. Checks all dimensions and angles, whether shapes are geometric or irregular... The Index Master, developed and used for years by engineers of Pump Engineering Service Corporation—(whose name in the Aviation Industry stands for the utmost in accuracy), is now made available to all designers, engineers and inspectors who have problems for which ordinary measuring devices are inadequate. Write for descriptive folder.

By the makers of

PUMP ENGINEERING SERVICE CORPORATION

Specialists to the Aviation Industry

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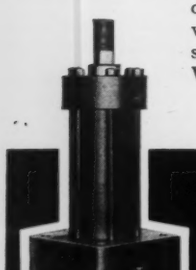
T-J HYDRAULIC CYLINDERS

■ If you require Hydraulic Cylinders, Tomkins-Johnson Non-Rotating Double-Acting Cylinders will provide positive operation with maximum efficiency and trouble-free service.

■ Designed for low or high pressures (up to 2000 lbs. per sq. in.) in either plain or cushioned action, T-J units may be secured in a number of styles, one of which will suit your requirement.

■ Catalog No. H-37 gives complete information on T-J Hydraulic Cylinders, in addition to valuable engineering data and charts that should be in every engineer's work file. Write for your copy today.

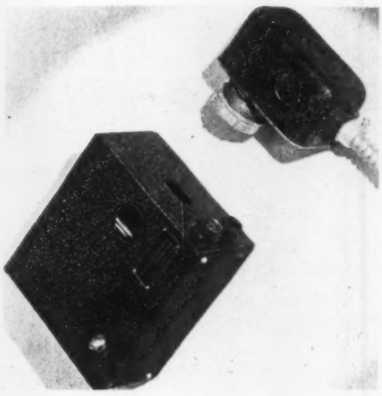


TOMKINS-JOHNSON Company

618 N. MECHANIC ST.

JACKSON MICHIGAN

vard, Long Island City, N. Y. The unit operates on 110-volt, 60-cycle, alternating current, and requires a minimum of three F. C. on the photocell. Impulses required are 1/20 of a second between each operation. The light source included with the equipment

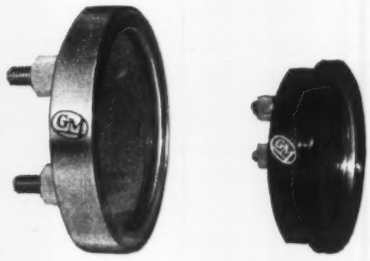


Impulses of 1/20-second are required between each operation of the Model 50 photoelectric relay control

is furnished with a 32-candlepower automobile type bulb and will operate the control at a distance of 25 feet. The light beam may enter two sides of the box, special knock-outs being provided. Vacuum tube life is approximately 3500 hours; photocell should operate at least 10,000 hours.

Barrier Type Cells Added to Series

LATEST additions to the G-M Visitron series of phototubes are two new barrier type cells, having twice the output of preceding units. Produced by G-M Laboratories, Inc., 1731 Belmont avenue, Chicago, the



Twice the output of preceding units is available with two new barrier type cells

type F2A has a nontarnishable metal case; type F3 has a Bakelite case. When desired both cells can be supplied with visual filters to give them a color response equivalent to that of the human eye.

Metal-Clad Switch Has Overtravel

METAL-CLAD micro switch, having an overtravel of ¼ inch, known as Series Q, is announced by Micro Switch Corp., Freeport, Ill. The switch has a

Announcing--

A MOTOR STARTER TO SUIT YOUR "SPECS"

THE CR7006-D51—Covered With New Features

- Small Size
- Clamp-type Terminal
- Heavy-duty Solenoid Magnet
- Easy-to-remove Contacts
- Isothermic Overload Relay

INTO this new G-E full-voltage motor starter we have incorporated all the characteristics demanded by modern machine practice.

It is compact—can be fitted into almost any design where a motor starter is required. Yet it meets the requirements of the Underwriters' Laboratories.

Write now for booklet GEA-2964, which shows *why* this starter will suit the most exacting machine requirements. General Electric, Schenectady, N. Y.

General Electric
Dept. 6B- 201
Schenectady, N. Y.

Please send me a copy of publication GEA-2964 on the new CR7006-D51 motor starter that's designed for machines.

Name.....

Firm.....

Address.....

City.....

080-148

GENERAL ELECTRIC